



**USC** University of  
Southern California

# Facility Design Guidelines

Revision 2023.03

07/30/2023

## INTRODUCTION

### USC Facilities Design Guideline Team

This document is managed and maintained with participation from Facilities Planning and Management (including Facilities, Capital Construction Development and Real Estate & Asset Management), Environmental Health and Safety, Department of Public Safety, and Information Technology Services.

### Direct all questions, comments and suggestions regarding this document to:

USC Facilities Planning and Management  
Attn: Jon Soffa, University Architect  
[soffa@usc.edu](mailto:soffa@usc.edu)

### Overview and Use

USC developed the *USC Facility Design Guidelines* for the use by architectural, engineering and construction teams involved in proposed USC construction projects. Outlined in the guidelines are USC standards and preferences for typical/common USC design and construction topics. Standards and preferences for quality and performance levels, administrative procedures, systems processes, systems, manufacturers, products, and installation are included. These guidelines are compatible with various project delivery methods, including Design/Bid/Build, CM @ Risk and Design/Build.

### Programming/Feasibility Study:

USC typically assembles a project team to prepare a Programming/Feasibility Study at the start of each new proposed project. The feasibility study establishes quality and performance levels that will inform aspects of the program design from infrastructure through project budgeting.

### Programming/Feasibility Study Typical Contents:

- project goals
- room area summary
- room specific diagrams
- diagrammatic floor plans
- building stacking diagrams
- narrative definition of major building systems
- site utility availability, access and connections
- conceptual exterior elevation perspectives that describe the project
- cost and schedule model

The *USC Design Guidelines* will partner with the Programming/Feasibility Study, and other project-specific criteria, and will be distributed at the start of the conceptual/schematic design phase. The programming team will review the guidelines to become familiar with USC expectations, standards and preferences. Teams should refer to the Request for Proposal (RFP) for project-specific requirements.

### Organization of Guidelines:

USC's preference is that construction specifications be organized according to The Construction Specifications Institute's (CSI) MasterFormat 2004. These guidelines are organized in "Sections" that correspond with this numbering system. Sections where USC has a preference or specific standard are included in these guidelines.

### Content and Focus of Guidelines:

Each Section of these guidelines are a custom document with its content depending on its relevance and importance to USC. For example:

- Sections on building systems (MEP, IT, Security) are extensive.

- The Structural Section is almost exclusively about processes as each building will have a unique structure depending on size, shape, site and budget

Many architectural materials and products are project specific and will be dealt with on a project-by-project basis. Architectural Sections only include information if USC has specific requirements or preferences, including the following:

- Materials (such as finishes and finishing techniques)
- Products (such as fire extinguishers)
- Quality assurance (such as mock-ups)
- Administrative processes about how/when something occurs (such as selection and approval)
- References to other relevant or related USC documents (such as specifications for door hardware and elevators)

### **Regulatory Requirements:**

Some regulatory requirements (such as those pertaining to accessibility) are only generally referenced in these guidelines. Specific codes, laws, regulations, reviews and jurisdictional procedures change periodically and are not included or superseded by this document. Each project team is responsible for reviewing and verifying applicable project-specific regulatory requirements with the USC Project Manager prior to and during design and construction.

### **Deviation from the *USC Design Guidelines*:**

The Project Manager will distribute and review the *USC Design Guidelines* with the design team prior to the start of programming or design. The project team must review these guidelines in detail with all of their sub-consultants. Items that are listed as disallowed may not be reconsidered in the deviation process. The preferences stated in these guidelines reflect:

- What USC requires in their projects
- The quality level expected
- Products already used on campus and that can be maintained
- Products that work well with other existing facilities or systems

The *USC Design Guidelines* does not use the phrase “or equal” when listing preferences. If project teams want to propose alternatives they must follow the deviation process. In the event the design team believes that direction provided in these guidelines is not appropriate, is unclear, or they would like to suggest an alternative for a specific USC facility or project, the team must ask the USC Project Manager for the Deviation Form(s) and list those items. USC’s Project Manager will arrange a meeting to review the Deviation Form(s) with various campus stakeholders (FPM, Security, ITS, EH&S or others). USC can approve, deny or ask the team to submit more details with evidence that their selected alternate is equal to or surpasses the preference in performance, first costs, energy savings, life cycle costs and long term maintenance provided in these guidelines. Deviations from the *USC Design Guidelines* require approval from the USC Project Manager.

### **Project Communication**

The USC Project Manager is the USC point of contact for all project information. All requests for information, meetings, building access and project organization go through USC’s Project Manager. It is the Project Manager’s responsibility to put design teams in contact with FPM, ITS, Security, EH&S or other USC groups on campus for meetings and information gathering.

### **Drawings Standards**

- Link to USC mechanical, electrical, plumbing, fire protection, access control drawing standards as well as commissioning guidelines, landscape design guides, and other related documents:  
<http://facilities.usc.edu/standards>

**Milestones and Meetings**

All project teams must review their contract with USC for milestone meetings, deliverables and documentation requirements. The following list of review meetings does not supersede the contract. The number of design review meetings by phase will be dictated by the scope and schedule of the project and shall be reviewed with the USC Project Manager prior to the start of work. At this time USC's Project Manager will assist the team in setting up specific meetings with FPM-Facilities, IT, Security, EH&S and other entities that need to be involved in early decisions. Prior to any design work the team must review:

- *USC Design Guidelines*
- Feasibility and Program Study
- As-builts (if applicable)
- Survey
- Hazardous Materials report
- Soils/Geotechnical report (or reports from adjacent buildings)
- Seismic report (if available on renovations and additions)
- Campus Master Plan
- Other information as applicable

**Project Deliverables**

The Design Team must submit a list of deliverables for all disciplines to USC's Project Manager to review prior to the kick-off meeting for that phase.

**Plan Check:**

USC University Park Campus and USC Health Science Campus projects are plan checked by the City of Los Angeles, patient care projects by OSHPD. Projects on Catalina Island are plan checked by Los Angeles County. For projects in other areas outside of LA City check with USC Project Manager and local jurisdictions. Coordinate with USC's Project Manager prior to contacting any city or other jurisdiction.

**Schematic Design Meetings:**

- SD kick -off meeting with team to review:
  - Project communication/roles
  - University review and approval schedule
  - Project approach
  - Scope
  - Deliverables (team to bring list of SD deliverables to this meeting)
  - Meeting schedule
  - Project schedule
  - Budget
  - *USC Design Guidelines* deviation process
- Project user groups
- University Architect
- FPM-Facilities to review campus utility infrastructure and building systems
- Campus reviews (Security, IT, EH&S, and other university groups as required)
- Preliminary review with Regulatory Agencies
- FPM-Facilities review
- Board of Trustee Approval
- Other meetings as necessary

**Design Development Meetings:**

- DD Kick -off meeting with team to review:
  - Project communication/roles
  - University review and approval schedule
  - Project approach
  - Scope
  - Deliverables (team to bring list of deliverable to this meeting)
  - Meeting schedule
  - Project schedule
  - Budget
  - *USC Design Guidelines* deviation process
- Campus reviews
- Project user groups
- Preliminary review with regulatory agencies
- Energy analysis – cost benefit analysis of all energy consuming systems demonstrating a seven (7) year pay back.
- Building Commissioning review
- Other meetings as necessary

**Construction Documents Meetings:**

- CD Kick-off meeting with team to review:
  - Project communication/roles
  - Deliverables (team to bring list of deliverable to this meeting)
  - Meeting schedule
  - Project schedule
  - Budget
  - *USC Design Guidelines* deviation process
- 50% Construction Documents meetings:
  - Campus review
  - Project user groups
  - Preliminary review with Regulatory Agencies
  - Other meetings specific to project as necessary
- 90% Construction Documents meetings:
  - Campus reviews
  - Project user groups
  - Preliminary review with Regulatory Agencies
  - Other meetings specific to project as necessary
  - Building permit & plan check review city of Los Angeles
- Other meetings as necessary

**Construction Administration Meetings:**

- Job site meetings
- Kick-off meeting with team to review:
  - Project communication/roles
  - USC Construction protocols
  - Procedures for RFI's, submittals, bulletins, and change orders
  - Meeting schedule
  - Project schedule

- Construction budget
- Other meetings as necessary

### Room Numbering

All new and/or modified building room numbering schemes must be prepared with the input and approved by a representative of the Department of Space Management. Design and construction teams must request a meeting with the Department of Space Management through the USC Project Manager to coordinate room numbering. This coordination is critical and must happen before the final Schematic Design documents are submitted, again at 50% Design Development and again at 50% Construction Documents at a minimum. Anytime rooms are added, deleted or re-named, this coordination must occur.

The USC Department of Space Management is responsible for inventory of all university space, including:

- Identification of individual room usage, occupants, and the overall utilization of university space
- Conducting an annual Space Utilization Survey that requires on-sight verification
- Reviewing and ensuring the accuracy of floor plans for all university owned buildings

### Calculating Square Footage (Floor Area)

For the sole purpose of project space planning, programming, feasibility planning, and design of USC owned facilities: All reports, studies, and incremental design submittals shall include a tabulation of Net and Gross square footage for USC's use. The resulting Net/Gross Efficiencies for each level and the total building will be calculated as follows:

- **Gross Floor Area:** The sum of all areas on a floor of a building included within the outside faces of its exterior walls and from the center lines of walls separating buildings.
- **Net Useable Floor Area:** The gross floor area of a building or structure measured to the centerline of the demising wall, excluding elevator shafts, stairwells, mechanical shafts, floor area for the parking of motor vehicles, unoccupied/unusable attics and basements and electrical and mechanical, and plumbing equipment rooms.

### Integrated Building Design Process

USC requires that design teams strategize building systems and present different approaches in Schematic Design looking for the most appropriate building systems that fit the buildings function, energy efficiency goals and the construction budget.

MEP systems should be part of the building's design concept not an afterthought after the architectural scheme has been set. Utilities (HVAC ducts, electrical, telecommunications, plumbing, etc.) in the building interstitial space should be zoned horizontally and vertically to organize services and to ensure the efficient movement of air and organized runs for utilities.

### Sustainable Design Principles

USC requires design teams to design and construct buildings in accordance with campus Sustainability Resolutions adopted by its Board of Trustees.

- Link: <http://green.usc.edu/content/campus-sustainability-resolutions>

### Specifying Comparable Products and Materials

USC does not use the phrase "or equal" in their specifications and prefers that design teams specify at least three qualified products. Where specific one-of-a-kind materials or products are required USC may grant exceptions.

### Hazardous Materials

USC has certain hazardous abatement procedures that are required based on the age of the buildings and materials typically found in existing buildings on campus. Request a Hazardous Materials Report from the USC Project Manager. The following items and/or others may be present in existing buildings and/or on-site:

- Lead
- Asbestos
- ACM
- Tritium
- PCB's
- Methane

## University of Southern California Website

The USC Website contains many documents that the design team will use and reference during the course of the programming, design and construction process. The following is a list of some of the major sources:

- USC Directories  
<https://my.usc.edu/wp/faculty/SearchForm.do>
- Homepage for USC FPM Facilities (formerly FMS)  
<http://www.usc.edu/fms/>
- Homepage for USC FPM Project Management (formerly CCD)  
<https://fpm.usc.edu/capital-construction-development/>
- Homepage for USC FPM - Real Estate and Asset Management (RE)  
<https://fpm.usc.edu/real-estate/>
- USC Sustainability  
<http://green.usc.edu/>
- FPM Standards and Guidelines  
<https://fpm.usc.edu/standards-guidelines/>
  - USCFDG - Facility Design Guidelines
  - AMMA - Adaptive Mitigation Management Approach
  - University Park Campus Specific Plan
  - Design Guidelines
  - Specifications
  - Installation Details & References
  - Project Close Out
- USC Maps  
<https://fpm.usc.edu/maps/>
- USC Graphics and Colors  
<http://identity.usc.edu/>

END OF INTRODUCTION

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# USC DESIGN GUIDELINES

## 01 0000 GENERAL REQUIREMENTS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are described in this document for the following:
1. Exterior mockups.
  2. Exterior brick masonry.
  3. Extra stock ("attic stock") materials.
  4. Construction waste management services.
  5. Facility waste management, including waste equipment.
  6. Existing conditions, including evaluations and reports, for water table levels and methane gas.
  7. Signage, including temporary, Project identification, and site signage.
- B. The following table summarizes the types of particular requirements identified within this Section:

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS, GENERAL

- A. Temporary Signage and Project Identification Signage: Comply with "Site Signage" requirements and the following:
1. Administrative Requirements: Obtain written approval from the University prior to erecting, exhibiting or displaying signs or other media devices. Include the following information for review and approval by the University:
    - a) Form or type (e.g., panel signs, illuminated signs).
    - b) Dimensions.
    - c) Content (e.g., text, artwork, logos).
    - d) Location(s).
  2. Disallowed: Identification on vehicles remaining on-site overnight or longer bearing identification over six inches tall and more than six feet above ground.
- B. Site Signage: Obtain electronic media disc containing signage guidelines, layout and artwork from the University. See Exhibit A.
- C. Exterior Brick Masonry: Based on historic core buildings at the USC University Park Campus (UPC). Italian Romanesque or Collegiate Gothic architectural style, using a blended pallet of brick colors combined with cast stone, or similar, on the exteriors. No two buildings are exact matches of each other, and so are "cousins" in this respect rather than "twins." New buildings incorporating historic core architecture must use a similar and compatible brick blend, unless otherwise directed by USC.

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1. Required: Produce samples and mock-ups of the blend for review and approval by the USC Project Manager on a per-project basis.
  2. Preferred: Use the following blend recipe, based on Pacific Clay Products, Inc. "Ruffle Cut" as a starting point for developing the blend(s) for use on new construction:
    - a) Imperial Peach: 30 percent.
    - b) Sunset Red: 20 percent.
    - c) No. 590: 30 percent.
    - d) Burgundy: 10 percent.
    - e) No. 190: 10 percent.
- D. Exterior Mockups: The purpose of the mockup is to define the look and quality of the exterior wall assembly, including base, middle, window, corner and parapet conditions.
1. Required: Schedule and convene a preconstruction meeting with the University's Project Manager, Project Architect, engineers, designers and other key Project members as required and appropriate. Discuss and document the following:
    - a) Composition of Mockup: Multiple assemblies and subassemblies. Prepare a list of components, materials, products and similar items as agreed.
    - b) Location of Mockup: On-site, where agreed, as a freestanding structure (i.e. mockup will not become part of finished construction).
  2. Submit Shop Drawings of mockup to University's Project Manager for approval prior to construction of mockup.
  3. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials.
- E. Construction Waste Management:
1. Required: Experienced construction and demolition waste management firm with a record of successful waste management coordination of similar projects and complying with the following:
    - a) Licensed and permitted by The City of Los Angeles.
    - b) Diversion Rate: Not less than 69 percent.
  2. Preferred: USC has a contract with a preferred vendor for daily campus operations. Proposals from other firms will be considered under the following conditions:
    - a) Compliance with other requirements described above.
    - b) Scope and type of services meet or exceed the USC preferred vendor.
    - c) Total cost of services is less than that of the USC preferred vendor.
- F. Facility Waste Management: USC has a contract with a waste management firm that sorts recyclable materials and waste materials from the facility's waste bins and waste compactors.
1. Required: For each USC campus, and not later than the Design Development phase, the Architect shall meet with the USC Project Manager to discuss and establish the following:
    - a) Location, by area, of waste bins/waste compactors on Project site.
    - b) Size, shape and configuration of waste bins/waste compactors within the designated location.
- G. Exterior Access to Basement Level

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1. Required: All grated areaways, non water tight hatches, or access to basements that will allow rainfall runoff to potentially enter require a minimum 8" high curb completely surrounding the structure to prevent inundation.

### 3. PROCEDURAL REQUIREMENTS – UNIVERSITY PARK CAMPUS (UPC)

- A. Subsurface Methane Detection and Mitigation: Portions of the campus are located in a "Methane Zone" or "Methane Buffer Zone," as identified by the City of Los Angeles.
  1. Required: The following must occur prior to construction activity:
    - a) Obtain a methane report from the USC Project Manager.
    - b) Mitigation measures will be defined by USC's methane consultant on a per-project basis.
    - c) Schedule and conduct a preinstallation conference to discuss, plan and coordinate activities.

### 4. PROCEDURAL REQUIREMENTS – HEALTH-SCIENCE CAMPUS (HSC)

- A. Subsurface Water Mitigation: The campus is located in an area known to have a high water table.
  1. Required: The following must occur prior to construction activity:
    - a) Obtain a geotechnical/soils report from the USC Project Manager.
    - b) Mitigation measures will be defined by USC's waterproofing consultant on a per-project basis.
    - c) Schedule and conduct a preinstallation conference to discuss, plan and coordinate activities.

### 5. PRODUCT REQUIREMENTS

- A. Temporary Signage: Comply with "Site Signage" requirements and the following:
  1. Required:
    - a) Wayfinding signage directing the general public to safe passage around or through the Project site.
    - b) Wayfinding signage directing authorized persons and entities to safe entrance into the Project site.
- B. Project Identification Signage: Comply with "Site Signage" requirements and the following:
  1. Signage Material and Finish Requirements:
    - a) Plywood Forms: Exterior-type, Grade B-B high-density concrete form overlay plywood; conforming to PS-1; size and thickness as indicated.
    - b) Panel Sign Finish and Graphics: Alkyd gloss enamel finish coat over exterior-use primer.
- C. Site Signage: Obtain sketch or drawing from University.
  1. Color Requirements: As approved by USC Project Manager and as follows:
    - a) USC Cardinal: Matching Pantone PMS 201.
    - b) USC Gold: Matching Pantone PMS 123.
- D. Extra Stock ("Attic Stock") Materials: Materials and quantities will be determined on a per-project basis.

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1. Required: Consult and coordinate with the USC Project Manager to establish list of extra stock materials and quantities.
- E. Storage of Extra Stock ("Attic Stock") Materials:
1. Required: Coordinate and establish location with USC Project Manager.
  2. Preferred: Store materials indoors at Project site. Usually store in the same building where the materials were installed, otherwise another location on Project site will be assigned.
  3. Disallowed:
    - a) Unsecured storage.
    - b) Unprotected conditions.
    - c) Offsite storage, unless approved in writing by USC Project Manager.

### 6. INSTALLATION REQUIREMENTS

- A. Temporary Signage and Project Identification Signage: Comply with "Site Signage" requirements.
- B. Site Signage:
1. Quality Assurance Requirements: Engage an experienced sign painter to apply graphics.
  2. Lettering/Font Style Requirements:
    - a) Caslon.
    - b) Frutiger.
  3. Lettering/Font Size Requirements: As indicated and approved.
  4. Finishing Requirements: For sign posts, edges and back.
    - a) Color: USC Cardinal.
- C. Exterior Access to Basement Level
1. Required: All grated areaways, non water tight hatches, or access to basements that will allow rainfall runoff to potentially enter require a minimum 8" high curb completely surrounding the structure to prevent inundation.

### 7. EVALUATION or COMMISSIONING

- A. Evaluation tests and inspections will be determined on a per-project basis.
1. Required: Consult and coordinate with the USC Project Manager to establish required tests and inspections including, but not necessarily limited to, custom fabrications and assemblies (such as storefronts and curtain walls).
- B. Commissioning will be determined on a per-project basis.
1. Required: Consult and coordinate with the USC Project Manager to establish commissioning requirements.

### 8. EXHIBITS

- A. Construction Signage
- B. Building ID Signage

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**USC DESIGN GUIDELINES**

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 01 8100 FACILITY STRUCTURAL PERFORMANCE CRITERIA

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document. For other related requirements; refer to 13 4800 ACOUSTICS AND VIBRATION REQUIREMENTS.
- B. All new facilities, new additions, and existing buildings requiring major renovation and/or seismic strengthening shall be designed in accordance with USC Standards and current City of Los Angeles Building Code.
- C. Where applicable, verify the load-bearing capacity of the existing structural elements to support the new design loads including all previous renovations. Review as-built conditions of lateral load resisting systems with respect to ductility and post elastic energy dissipation and deflections.
- D. Where alterations are made to the structural elements in existing buildings, these elements individually and the buildings as units, must maintain adequate strength to safely resist both gravity and lateral loads. Any resulting deficiencies must be reinforced accordingly. All structurally modified components shall be brought into accordance with current code. Renovations that serve to increase the gravity load on any structural element by more than 5% shall be brought into compliance with current code. Renovations that serve to increase the seismic force in any structural element by more than 10% shall be brought into compliance with current code. Evaluate and identify whether or not a full or partial seismic renovation is recommended per code.
- E. The structural concepts and considerations as noted herein shall be evaluated, reviewed, discussed, and confirmed with the University Project Manager during the early stages of the project. Concepts shall be developed in sufficient detail to adequately identify the effect on the project program, cost and schedule with respect to various options.

### 2. STRUCTURAL DESIGN REQUIREMENTS AND INITIAL PHASE SCOPE REVIEW ITEMS:

- A. Minimum uniform basic design live loads shall conform to City of Los Angeles current code. Increase live load above code limits where current and future program flexibility is required as discussed with University Project Manager. Provide bay studies of various loading options for pricing and review.
- B. Provide a 20 psf allowance for partitions on floors where specified live load is less than 100 psf.
- C. Provision shall be made in designing floors for a concentrated load of 2000 lb, placed upon any space 2.5 ft square, wherever this load upon an otherwise unloaded floor would produce stresses greater than those caused by the uniform load.

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- D. In order to provide a flexible design allowing certain range of occupancy changes in the future, generalized live load categories should be applied to large areas preferably one category to any one floor in coordination with University Project Manager.
- E. All buildings and buildings components shall be designed in accordance with a minimum Occupancy Category III per code regardless of building program. Essential Facilities shall be classified as Occupancy Category IV if the building program requires it. Occupancy Category II may be acceptable for non-student buildings subject to confirmation by USC PM.
- F. Foundation: Provide foundations options based on available geotechnical reports for site and adjacent or nearby sites shall be prepared. Review appropriateness and costs as applicable for options including footings, mat foundations, deep foundations (drilled piers, piles and caissons), including the potential for soil-ground remediation measures.
- G. Schematic Design Phase Criteria: Provide Design Criteria including Governing Codes and Reference Standards, Design Live and Dead Loads, Seismic and Wind Load and Factors, and Special Loads such as Exterior Finish, and Vibration; Material Strengths and Types of Concrete and Concrete Materials, Precast Concrete, Reinforcing Steel, Post Tensioning and Pre-Stressing, Masonry, Structural Steel including Metal Deck, Welding, and Bolts, Miscellaneous Steel, Glu Laminated Wood, and wood. Identify target drift limits for primary structure and non-structural architectural components.
- H. Schematic Design Phase Structural Framing Options: Compare and contrast structural framing options including reinforced concrete, structural steel, precast, masonry and timber as appropriate with respect to floor and roof bay spans, cost efficiency, and floor and building heights and program requirements. Identify advantages and disadvantages for the various structural options with respect to the vertical gravity systems, lateral load resisting systems, construction schedule impacts, campus construction activity impacts, and cost effectiveness. Consideration of systems ability to be retrofitted or renovated should also be addressed. Preview structural system and coordinate interface with MEP systems and routing.
- I. Structural systems shall utilize sustainable and low VOC materials and building practices where practical in accordance with sustainability and LEED requirements as required by University Project Manager.

### 3. PROCEDURAL REQUIREMENTS DURING INITIAL PHASES

- A. Provide multiple framing options using various materials including concrete, steel, masonry, wood, etc. Systems shall be appropriate for building massing and program. Final selection of system will be in conjunction with USC Project Manager. Multiple systems should be developed through Schematic Design phase for accurate pricing, schedule and program impact comparisons.
- B. Consider and account for adjacent structures and identify interaction issues during system development. Issues to consider and evaluate include method of excavation including temporary shoring concepts, proximity to existing basements, impact of new basements, deflection monitoring of existing structures during construction, building separation requirements, .

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- C. Identify anticipated primary structure vertical and lateral deflections. Coordinate and evaluate deflection magnitudes with respect to exterior façade joints, movement of façade between levels and façade support details. Coordinate and confirm with design team and University Project Manager regarding acceptable levels of facade performance relative to building function after extreme seismic events, and up front construction cost relative to repair cost.
- D. Lateral Load Resisting Systems: Lateral load resisting system shall be appropriate for building program and massing. Consideration of systems impact to current and future interior space planning and potential nonstructural detailing issues shall be evaluated. Special attention shall be paid to systems containing shear walls, braced frames and gusset plates, unbounded braces, etc. Lateral load resisting systems shall be code compliant and detailed for post elastic ductility and energy dissipation with limited damage.
- E. Structural Vibration: Consider, evaluate and accommodate vibrational and acoustical issues in accordance with Section 13 4800. Consider vibration coming from external sources, mechanical equipment and footfall of occupants. Consider vibration transmission between adjacent spaces on floors and between floors. Consider vibration isolation at labs and other vibrationally sensitive program areas. Coordinate acceptable acoustical and vibrational limits with vibration basis of design.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 01 8316 EXTERIOR ENCLOSURE PERFORMANCE REQUIREMENTS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are described in this document for the following:
1. Exterior enclosure for mechanical, electrical and/or plumbing equipment.
- B. The following table summarizes the types of particular requirements identified within this Section:

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS, GENERAL

- A. Application Requirements:
1. In areas where mechanical, electrical and/or plumbing equipment is located on the exterior of a building, provide for an enclosure that meets the following performance requirements:
    - a) Non-climbable enclosure on all sides of the equipment that provides for restricted access to equipment. Where approved, the wall of a building may serve as the fourth side to the enclosure.
    - b) Entrance door that swings out of the enclosure. Secondary door to be provided where required based on size of the enclosure.
    - c) Entrance door shall be lockable either via key, pad lock or pad lock with chain combination
    - d) Minimum 5' height
    - e) At least 2' clearance on all sides of equipment pad, or minimum equipment clearance requirements, whichever is stricter.
  2. Disallowed: Chain link fencing.
- B. Provide design for review and approval by University Architect and Facilities Management Services.

END OF DOCUMENT

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## 01 9100 COMMISSIONING PROCESS REQUIREMENTS

### 1. OVERVIEW

- A. Purpose: University of Southern California is committed to commissioning new building construction projects and major building renovation projects. Renovation projects other than simple remodeling, potentially fits into the major renovation category. A major renovation which includes new Mechanical, Electrical and Plumbing (MEP) or other systems will typically have changes/modifications to the Sequences of Operation from the existing project. Because of this, the renovation project will benefit from Commissioning. This section will establish the minimum commissioning guidelines and responsibilities of the Commissioning Agent Firm for work performed at the University, as well as inform the Architect/Engineer of their responsibilities with the commissioning process. This section also details the responsibilities of the Facilities Planning & Management (FPM) Commissioning Administrator, Facilities Planning & Management (FPM) Project Manager, Contractor and the Sub-Contractors/Vendors.
- B. Commissioning is a systematic process of insuring that the building systems and equipment operate and perform according to the owner's project requirements and operational needs. The commissioning process oversees, verifies and documents that the facility and its systems and equipment are planned, designed, installed, tested, operated and can be maintained as required to meet the owners functional intent and project contract documents. The commissioning process does not relieve the contractor from providing a finished and fully functional product.
- C. Related Documents: General Commissioning Requirements 01 91 13 of the Specifications apply to this Section.
- D. The commissioning process generally begins during Design Development and continues on through occupancy. Design-Phase and Construction-Phase activities are described in this document. The Construction Phase activity is sub divided into Bid Phase, Construction Phase, Commissioning Functional Performance Testing Phase, Opposite Season Commissioning Functional Performance Testing Phase and Warranty Phase Commissioning.
- E. The Commissioning Process at USC focuses on the Mechanical, Electrical and Plumbing (MEP) and any other building infrastructure systems such as Fire Protection, Security and Access Control.
- F. The commissioning process is performed by the Commissioning Team. During the design phase the commissioning team includes FPM Commissioning Administrator, Commissioning Agent Firm, FPM Project Manager, Architect and Design Engineers. During the construction phase the commissioning team expands to include the General Contractor along with Sub-Contractors and

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Testing and Balancing Vendors.

- G. Applicable Codes and Standards include the following. This list is updated on regular basis.
1. The commissioning process is generally governed by ASHRAE Guideline 0-2013 – The Commissioning Process.
  2. California Title 24 Energy Code – Commissioning Requirements
  3. LEED Commissioning Requirements (as determined)
- H. Hiring the Commissioning Agent Firm: The following steps describes the procedure as to how the FPM Commissioning Administrator facilitates hiring of the Commissioning Agent Firm. The FPM Commissioning Administrator,
1. Initiates discussion at the Project inception and consults with FPM Project Management team about the need to hire the Commissioning Agent Firm early on the project. The benefits of hiring the Commissioning Agent Firm during the Project inception phase are explained and discussed.
  2. Consults with FPM Project Management team about any specific requirements of the Project and any particular Commissioning Request for Proposals (RFP) requirements.
  3. Provides Draft Commissioning Request for Proposal (RFP) tailored to the project, for review and approval of the FPM Project Manager.
  4. Reviews comments (if any), from the FPM Project Manager and revises the Commissioning Request for Proposal.
  5. Selects and recommends qualified Commissioning firms that are suitable for the type of project, from the University Commissioning Provider Vendor List.
  6. Sends RFP's to all the Commissioning Providers selected.
  7. Receives the Proposals.
  8. Reviews the Proposals that are received. They are reviewed based on several criteria such as past experience with similar projects, previous project experience in this or other Universities, the strength of the Team etc.
  9. Selects two or three Commissioning Providers from the original list for Interview.
  10. Invites the selected Commissioning Providers for Interview, conducted by the FPM Project Management Team and Facilities Management Team.



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11. Initiates discussion to review the Commissioning Agent Firms that are interviewed. The strengths and weakness of each Commissioning Provider is discussed and Recommends a Commissioning Provider Firm to the project.

### 2. DESIGN PHASE COMMISSIONING REQUIREMENTS

- A. The Commissioning Process begins very early in a project. The Owner documents the Owners Project Requirements (OPR) before design begins, to guide the entire project. This OPR includes the project design intent, the document requirements, testing and training requirements, and any other items necessary to facilitate a successful project.
  1. If the Commissioning Agent Firm is hired during this time, the initial commissioning plan, training requirements and systems manuals outlines are also developed.
  2. The Commissioning Agent Firm conducts meetings with the owner's staff and can lead the Owner's Project Requirements development and assists during design, construction, and testing in meeting the OPR.
- B. The Design Team develops the Basis of Design (BOD) that outlines their plan to design the project according to the Owners Project Requirements.
- C. Once the Owner had approved the BOD, the Commissioning Agent Firm assists with other commissioning requirements such as providing the Commissioning Specifications, and a review of Mechanical, Electrical and Plumbing Specifications provided by the Design Team for the design package.
- D. The Commissioning Agent Firm conducts several design reviews to determine the level of design team quality control and conformance to the OPR. The Commissioning Agent Firm, also monitors the development and reviews the control system design. Achieving a functional, coordinated control system in the design stage, greatly facilitates the bidding, construction and functional testing of the systems of the project. Design phase reviews also focus on coordination checking between trades and review of the building systems.
- E. The following are the design phase expectations and responsibilities of each commissioning team member/group:
  1. Commissioning Agent Firm:
    - a) Conduct meetings with the Owner to understand the Project needs of the Owner and develops the Owners Project Requirements. Guide the Owner in selecting the best system/s for the given project.
    - b) Review the Basis of Design provided by the Design Team to verify conformance with the Owners Project Requirements. Consult with the Owner regarding the adequacy of the Basis of Design.

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- c) Review MEP drawings and specifications. These reviews are conducted for verifying the completeness and adherence to Owners Project Requirements. These reviews are conducted once at the end of Design Development, once at 50% Construction Development Phase and once again at 100% Construction Development completion. Review comments are back checked in the subsequent design submission.
- d) Participate in design review meetings.
- e) Develop and maintain a Design Deficiency Report detailing issues generated through the Design review process. Submit the Report to the FPM Commissioning Administrator.
- f) The Commissioning Agent Firm's comments are consolidated with Facilities Management Service's comments and forwarded to the Project Manager by the FPM Commissioning Administrator.
- g) The Project Manager forwards the consolidated review to the Architect/Engineer Design team for review/incorporation into the design/construction documents.
- h) The Commissioning Agent Firm verifies that their comments have been responded and incorporated where relevant. The Commissioning Agent Firm tracks any open items of the Design Deficiency Log and ensures that they are addressed by the Architect/Engineer Team.
- i) Develop the relevant Commissioning Specifications and the Commissioning Plan and provide to the Architect/Engineer team for incorporation into the contract documents. The Commissioning Plan should describe the systems scheduled for commissioning, the nature of the testing to be performed, those personnel of the Commissioning Team including the Contractor and Sub-Contractor required to be in attendance, the documentation of Commissioning efforts such as Pre-functional Checklists and Functional Performance Test Procedures that will be required and the party responsible for the documentation.
- j) Outline test plans for each equipment and the systems to be commissioned. Include manpower requirements for construction trades where applicable.
- k) Provide a draft commissioning schedule to be incorporated into the overall project schedule. Include estimated time required for equipment and systems testing.
- l) Review the project specifications to assure the following:
  - i. All necessary documentation from the Contractor is specified
  - ii. Clear procedures are established for the commissioning process

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- iii. Any special equipment or instrumentation needed for obtaining measurements during performance testing is included
- iv. Adequate Training Program for the University's building operation personnel for proper operation and maintenance of the equipment and systems is provided.

### **2. Architect/Engineer Team**

- a) Review the Owners Project Requirements documentation in collaboration with the University and the Commissioning Agent Firm.
- b) Develop and provide the Basis of Design of the Project. The Basis of Design developed should align with the Owners Project Requirements that was developed earlier in the Project. Respond to questions from the commissioning team and the Owner pertaining to the Basis of Design.
- c) Review the Commissioning Plan.
- d) Meet with the Commissioning Team to discuss and coordinate the review of the design documents.
- e) Incorporate the commissioning specifications and any commissioning specific information into the design documents and specifications. Coordinate with the Commissioning Agent Firm regarding Specification Section content and formatting.
- f) Incorporate and respond to design review comments provided by the Commissioning Agent Firm and University FPM staff. These comments will be consolidated to avoid multiple responses from the Architect/Engineer team.
- g) Meet with the commissioning team as required to discuss comments developed during the design review.

### **3. FPM Commissioning Administrator**

- a) Ensure that the Project Management team has the latest revision of the University Commissioning Process and the General Commissioning Requirements Section 01 91 13 at the onset of the project. If a revision in University Commissioning Process and or the General Commissioning Requirements Section 01 91 13 is released during Construction Document development, discusses with the Project Management team to determine if the change can be incorporated into the design.
- b) Supports and oversee the activities of the Commissioning Agent Firm in partnership with the FPM Project Manager.

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- c) Design Review: Ensure that the Design review comments developed by the Commissioning Agent Firm are consolidated with the design review comments developed by the University Facilities Management Service to avoid multiple responses from the Architect/Engineer Team.
- d) Provide the consolidated Design Review comments to the Project Manager to be forwarded to the Architect/Engineer Team.
- e) Ensure that Design Review Comments are reviewed and responded to by the Architect/Engineer team. Track any open items on the issues log/report and ensure they are addressed by the Architect/Engineer team.

### 4. Project Management Team:

- a) Formally transmit the current University Design Standards, the University Commissioning Process and the General Commissioning Requirements 01 91 13, to the Architect/Engineer team.
- b) Provide the Construction Drawings, Specifications and if applicable, Equipment/Systems Submittals to the University FPM, and the Commissioning Agent Firm.
- c) Organize meetings to discuss cost or schedule impacts of comments developed during the construction document review process. Work with the Architect/Engineer team and Commissioning team to resolve issues that arise during the design process.
- d) Supports the FPM Commissioning Administrator on Commissioning related tasks.

## 3. CONSTRUCTION PHASE COMMISSIONING REQUIREMENTS

A. The Commissioning Process continues during the Construction Phase. Construction Phase includes Bid Phase, Construction Phase, Commissioning Functional Performance Testing Phase, Opposite Season Commissioning Functional Performance Testing Phase, and Warranty Phase Commissioning.

B. The following are the construction phase expectations and responsibilities of each commissioning team member/group:

### C. Bid Phase

#### 1. Commissioning Agent Firm

- a) The Commissioning Agent Firm is to chair a meeting with the proposing Contractors, Sub-Contractors and other specialty trades to define what is involved in Commissioning, to review the sequence and schedule of Commissioning work and to provide an explanation of

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Commissioning effort's importance to the project. Anticipated manpower requirements and timeframes for the Commissioning work is also reviewed.

### **D. Construction Phase**

#### **1. Commissioning Agent Firm**

- a) Coordinate the commissioning and start-up work with the General Contractor and Engineer of Record and ensure that the commissioning and start-up activities are accounted for in the master project schedule. Review and update the commissioning schedule and submit corrections to the General Contractor for inclusion in the overall project schedule.
- b) Update the Commissioning Plan to include all equipment and systems developed during the design phase. Develop project specific Commissioning Plan with input from Architect/Engineer team. Submit to the Commissioning Team.
- c) Review submittals of systems and equipment submitted by the Contractor/Project Management during the submittal process. Provide comments to the FPM Commissioning Administrator.
- d) The Commissioning Agent Firm's submittal review comments are consolidated with Facilities Management Service's comments and forwarded to the Project Manager by the FPM Commissioning Administrator.
- e) Develop Pre-Functional Checklists for all Systems/Equipment.
- f) Perform site visits to ensure construction is ongoing per the construction documents and that the commissioning schedule is on target. Document any deficiencies noted between field conditions and the construction documents during these walkthroughs. Verify the installation of equipment confirms to the contract documents.
- g) Review the ongoing incremental completion of the Pre-Functional Checklists by contractors who are responsible for each equipment. Review Pre –Functional Checklists are accurately capturing the progression of installation by the appropriate contractor. Identify any recurring deficiencies in installation of equipment, which may have been captured on Pre-Functional Checklists.
- h) Witness and spot check Testing and Balancing
- i) Witness HVAC Piping Pressure Test and Flushing.
- j) Witness Ductwork Testing and Cleaning.

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- k) Develop and maintain a construction deficiency report and distribute to the Commissioning Team. Verify corrections have been made as required.
- l) Conduct periodic commissioning team meetings. These meetings should occur at least monthly during the construction phase and weekly during the actual Functional Performance Test Phase.
- m) Attend selected construction meetings sufficient to advise the commissioning team on critical path milestone dates. Advise the Owner on any issues that has the potential to affect the Commissioning Process as originally envisaged.
- n) Review the start-up plans and equipment/component test procedures with the Commissioning Team and the FPM Commissioning Administrator to ensure all systems receive proper start-up and commissioning.
- o) Prior to equipment and system start-up, gather and review the final control sequences and interlocks and work with the Engineer of Record and the General Contractor/Sub Contractor until sufficient clarity has been obtained, in writing, to be able to write detailed Functional Performance Testing procedures.
- p) Witness the start-up/testing of equipment to ensure that the equipment is properly installed and ready for functional performance testing.
- q) Consult with the Engineer of Record, Project Manager, General Contractor and sub-contractors on the ongoing implementation of the Commissioning Schedule and keep the FPM Commissioning Administrator informed of any changes that result from this coordination.
- r) Provide the developed Functional Performance Testing procedures to the Commissioning Team for review.
- s) Develop Integrated Systems Testing Procedures to determine how the Combined Systems react during an emergency. Provide the developed Integrated Systems Testing procedures to the Commissioning Team for review.
- t) Review testing, adjusting and balancing (TAB) plan. Provide comments to engineer of record. Witness the actual TAB work and verify measurements as per requirements.

### 2. Architect/Engineer Team

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- a) Attend project construction meetings and report all concerns to the FPM Commissioning Administrator. Work with Commissioning Team to seek resolution to issues raised during these meetings.
- b) Assist Commissioning Agent Firm with the development of project specific testing documentation/requirements for all equipment and systems.
- c) Review construction deficiency report developed by Commissioning Agent Firm. Provide comments for each item and include relevant items in engineering Issues Log.
- d) Incorporate relevant comments from Commissioning Agent Firm and University Facility Management Service's comments to submittals.
- e) Coordinate with commissioning team regarding start-up plans and documentation. Ensure control sequences and interlocks are sufficiently developed to ensure detailed Functional Performance Testing procedures can be developed by the Commissioning Agent Firm.
- f) Review Pre-Functional Checklists, Functional Performance Testing procedures and the Integrated Systems Test documents and provide comments to the Commissioning Agent Firm and to the Commissioning Team.

### **3. FPM Commissioning Administrator**

- a) Attend project construction meetings and report all concerns to affected departments. Work with Project Management team to seek resolution to issues raised during these meetings.
- b) Ensure relevant submittals are provided to the Commissioning Agent Firm for their review and comment. Ensure that submittal reviews are completed concurrently with the Design Team and in a timely manner by the Commissioning Agent Firm.
- c) Distribute submittal review comments by the Commissioning Agent Firm to University FPM personnel for their review and comment.
- d) Ensure that Commissioning Agent Firm's submittal review comments are consolidated with University Facilities Management Service's review comments to avoid multiple responses from the Architect/Engineer Team.
- e) Provide the consolidated Submittal Review comments to the Project Manager to be forwarded to the Architect/Engineer Team.
- f) Review Pre-Functional Checklists, Functional Performance Testing

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procedures and the Integrated Test documents and provide comments to the Commissioning Agent Firm. Distribute to the FPM departments for their comments. Consolidate all comments and forward to the Project Manager.

- g) Perform periodic walkthroughs of the construction site. Coordinate with Commissioning Agent Firm and provide comments to be included in construction deficiency report.

### 4. Project Management Team

- a) Requests the Design Team and provides the submittals of Systems and Equipment that are commissioned, to the Commissioning Agent Firm for review.
- b) Forward Review Comments provided by the Facilities Commissioning Administrator to the Design Team for their review.
- c) Organize meetings to discuss cost or schedule impacts of comments developed from the construction deficiency report. Work with the Architect/Engineer team and Commissioning team to resolve issues that arise during the construction process.
- d) Supports the FPM Commissioning Administrator on Commissioning related tasks.

### 5. Contractor and Sub-Contractors

- a) Attend Commissioning meetings
- b) Coordinate the commissioning and start-up work with the Commissioning Agent Firm and ensure that the commissioning and start-up activities are accounted for in the master project schedule. Review and update the commissioning schedule and include it in the overall project schedule.
- c) Assist the Commissioning Agent Firm during Site Visits.
- d) Respond to Commissioning Agent Firm's enquiries promptly within the established timeframe.
- e) Conduct reviews and provides comments promptly for items such as Issues Log and Pre-Functional Checklists. Rectify deficiencies identified by the Commissioning Agent firm in a timely manner.
- f) Provide Trend Data for the Commissioning Agent Firm for their analysis as required.
- g) Complete the Pre-Functional Checklists incrementally as installation progresses.



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- h) Promptly inform the Commissioning Agent Firm of planned Start-up, Testing and balancing, HVAC Piping Pressure Test and Flushing, Ductwork Testing and any other activity within the scope of Commissioning.

### **E. Commissioning Functional Performance Testing Phase**

#### **1. Commissioning Agent Firm**

- a) Plan and conduct meetings to outline the scope of Commissioning during Functional Performance Testing Phase. Include the General Contractor, Sub-Contractors, Engineer of Record, Project Manager and FPM Commissioning Administrator.
- b) Consult with the Commissioning Team on the adequacy of the installation of each equipment and system. Verify that the installation is in conformance with the requirements of the design and construction documents.
- c) Confirm that the Pre-Functional Checklists, Start-up Reports, Testing and Balancing and Controls Checkout are completed and approved.
- d) Analyze the Trend Data provided by the Contractor and verify performance of Systems and Equipment adheres to the Design Intent.
- e) Commence Functional Performance Testing of each piece of equipment and its associated system. Functional Performance Testing is directed by the Commissioning Agent Firm and performed by the Contractor.
- f) Identify deficiencies discovered during the Functional Performance Testing process and make corrective recommendations. Maintain a master deficiency and resolution log, as well as a separate testing record. Provide Functional Performance Test results and progress reports to the Commissioning Team together with recommended actions. Track and re-test all deficiencies for completeness.
- g) Perform Integrated Systems Testing. Integrated Systems Testing is performed to review the coordination between systems, during an emergency or power failure, is as intended, per design.
- h) Review all equipment warranties and advise the Owner of any non-compliance with the specifications.
- i) Verify the accuracy and completeness of final testing, adjusting and balancing (TAB) reports.
- j) Witnessing of testing of equipment & Systems by others: Authority having Jurisdiction or Specialty Sub-Contractors: Witness all Owner-

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contracted tests or tests by others such as Specialty Sub-Contractors, Manufacturer's Personnel or Authority having Jurisdiction, over which the Commissioning Agent Firm may not have direct control. Review test documents and provide comments to the Owner. Assemble and document the results of these tests in the Commissioning Report or in the Operations and Maintenance Manuals as required by the Owner.

- k) Review the Training proposed by the Contractor to verify if it confirms with the contract documents.
- l) Coordinate with the General Contractor and participate in Operations and Maintenance staff training. Include any vendors and sub-contractors as necessary. Verify to Owner that this training has been satisfactorily completed, per the contract documents.
- m) Coordinate with Engineer of Record, General Contractor, Sub-contractors and all regulatory agencies to ensure all applicable local, State and Federal requirements have been satisfied.
- n) Review completed as-built records, including operation and maintenance manuals prepared by equipment manufacturers, fabricators or installers for inclusion in the Owner's Systems Manual. Once these documents have been completely assembled, review and provide comments to the FPM Commissioning Administrator.
- o) Develop the Project specific Commissioning Report. Provide a final commissioning report stating that all systems/sub-systems, components and major equipment meet the specifications and design intent of the project and has been installed properly. For each commissioned piece of equipment and system state that it has been installed correctly, is operating in a satisfactory manner and that University personnel have been trained on its use and maintenance. The report shall include an executive summary, list of participants and roles, Systems description, an overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the commissioning agent regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas: Equipment meeting the equipment specifications, Equipment installation, Functional performance and efficiency, Equipment documentation, and Operator training.
  - i. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented.

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- ii. The commissioning report shall include a summary of the design review process, submittal review process, and O&M documentation and training review process.
  - iii. Also included in the commissioning report shall be the issues log, commissioning plan, progress reports, submittal and O&M manual reviews, training records, test schedules, contractor completed pre-functional checklists, start-up reports, completed functional performance tests, the final approved sequences of operations, blank functional performance tests, and trend log analysis.
  - iv. Provide an electronic version of the draft Commissioning Report within one month after Functional Performance Test completion, for approval by FPM Commissioning Administrator. Once approved, submit an electronic copy and two copies of the printed version, compiled in D-Ring binder/s.
- p) Develop the Project specific Systems Manual. Compile a Systems Manual, which shall include information needed to understand, operate, and maintain the equipment and systems. This document is in addition to the record construction documents, and the O&M manuals supplied by the contractor. The Systems Manual shall include a narrative of the project scope, Site contact information, emergency contacts, utility connection and shutoff plans, description of all major systems, including equipment location plans and system flow and riser diagrams, basic operations and maintenance narratives, general site operating procedures, normal operation, emergency operation, basic troubleshooting, recommended maintenance requirements and logs, final control sequences and current operational requirements including schedules and set points, final test and balance information and copies of all special inspection verifications required by the enforcing agencies.
- i. Provide an electronic version of the Draft Systems Manual within one month after Functional Performance Test completion, for approval by FPM Commissioning Administrator. Once approved, submit an electronic copy and two copies of the printed version, compiled in D-Ring binder/s.

### 2. Architect/Engineer Team

- a) Provide prompt response to Commissioning Agent Firm's enquiries regarding Equipment or System Installation, and for items listed on the Issues Log.
- b) Attend Site Walk with the Commissioning Team and provide comments.

## **USC DESIGN GUIDELINES**

- c) Review and provide comments for Functional Performance Testing Documents and the Integrated Systems Testing Documents provided by the Commissioning Agent Firm.
- d) Support the Commissioning Agent Firm as needed during the Functional Performance Testing and Integrated Systems Testing.

### **3. FPM Commissioning Administrator**

- a) Provide FPM with Functional Performance Testing and Integrated Systems Testing schedules to facilitate witnessing.
- b) Oversee the Functional Performance Testing and the Integrated Systems Testing.
- c) Provide reports of deficiencies identified during the commissioning process to General Contractor and Project Manager. Track and ensure that these items are resolved.
- d) Attend commissioning meetings and forward any issues to the appropriate University personnel or departments. Ensure responses are forwarded to the Project Manager and General Contractor.
- e) Review all documents submitted by the Commissioning Agent Firm and provide corrective comments.

### **4. Project Management Team**

- a) Organize meetings to discuss cost or schedule impacts due to issues and comments identified on the commissioning deficiency report. Work with the General Contractor and the Commissioning team to resolve issues that arise during the commissioning process.
- b) Supports the FPM Commissioning Administrator on Commissioning related tasks.

### **5. Contractor and Sub-Contractors**

- a) Provide prompt response to Commissioning Agent Firm's inquiries regarding Equipment or System Installation, and for items listed on the Issues Log.
- b) Attend Site Walk with the Commissioning Team and provide comments.
- c) Review and support as necessary, and provide comments for Functional Performance Testing Documents and the Integrated Systems Testing Documents provided by the Commissioning Agent Firm.

## **USC DESIGN GUIDELINES**

- d) Conduct the Functional Performance Test as directed by the Commissioning Agent Firm.
- e) Rectify deficiencies identified during the Functional Performance Testing process and make corrective actions.
- f) Rectify deficiencies identified during the Integrated Systems Testing process and make corrective actions.
- g) Provide Training information for review by the Commissioning Agent Firm.

### **F. Opposite Season Commissioning Functional Performance Testing Phase**

#### **1. All Parties**

- a) Typically, four to six months after the initial Commissioning of the building systems has been completed, and if required by the Project contract, return to the site and perform Commissioning of the opposite season equipment mode. This is typically required when systems cannot be functionally tested with full load at the time of year when Functional Performance Testing is conducted. These requirements will be project-specific and outlined at project inception. The Commissioning process shall follow the same steps as the Functional Performance Test Commissioning process.

### **G. Warranty Phase Commissioning (Warranty Review)**

#### **1. Commissioning Agent Firm**

- a) At least six months prior to the end of the warranty period, review with the Owner and the University Operations personnel the operation of the systems and equipment and the condition of any outstanding issues related to the performance of the warranted equipment and systems. Request and verify Trend Data for all Systems and Equipment that was commissioned, from the Commissioning Team. The Commissioning Agent Firm should provide assistance to the University in developing reports, other documents and requests for services to manufacturers to remedy outstanding warranty problems. Once deficiencies have been corrected, the Commissioning Agent Firm is to provide oversight on any final testing required and to document the results in the Commissioning Record. Provide all supporting documentations to the FPM Commissioning Administrator.

#### **2. FPM Commissioning Administrator**

- a) Facilitate meetings with the University parties and the Commissioning Agent Firm.

## **USC DESIGN GUIDELINES**

- b) Facilitate the Trend Data Request by the Commissioning Agent Firm and coordinates with the commissioning team for collection and transmittal of the requested trend data.
3. Project Management Team
- a) Supports the FPM Commissioning Administrator on Commissioning related tasks.
  - b) Facilitate the Trend Data Request by the Commissioning Agent Firm and coordinates with the commissioning team for collection and transmittal of the requested trend data.
4. Contractor and Sub-Contractor
- a) Provide Trend Data for the Commissioning Agent Firm for their analysis as required.
  - b) Rectify deficiencies identified during the Warranty Phase and make corrective actions.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 02 2100 SURVEY

### 1. OVERVIEW

#### A. University Park Campus (UPC)

- I. Purpose: USC preferences and requirements are indicated in this document.
- II. UPC campus surveys to be coordinated with and tied into the UPC Mapping Control Survey.
  1. Topographic Design Surveys:
    - a) To be recorded with Los Angeles County Recorder's Office and performed by a California licensed Land Surveyor.
    - b) Request and integrate available recent topographic design surveys and aerials from University Project Manager.
    - c) Project Civil Engineer to field verify and investigate topographic design survey provided. Updated survey to be provided to the University Project Manager.
    - d) See table below for a list of topographic design survey requirements.
    - e) Horizontal, Vertical and EPOCH control guidelines are as follows:
      - i) A network of survey control monuments with Northing, Easting, and Elevation values has been established on the USC University Park Campus. All surveys, engineering plans, and architecture plans shall be tied to a minimum of three such monuments, the actual values used for such monuments, and the Epoch used.
      - ii) The Vertical Datum for the Campus is the National Geodetic Vertical Datum of 1929, LA City year 1985 adjustment.
      - iii) The Horizontal Datum for the Campus is the North American Datum of 1983 (NAD83) HPGN California State Plane Coordinate System of 1983 (CCS83) Zone 5 (0405).
      - iv) The two following Epochs (adjustments) of said CCS83 are in use on the Campus.
        - (1) Legacy Use (for older and some current plans): 1991.35 Epoch
        - (2) Current and Future Use: 1995.0 Epoch.
      - v) The Campus Control Recorded Survey Map provided herein clearly shows the Horizontal (both Epochs) and Vertical (NGVD29-LA City 1985) values for each Campus Control Monument
      - vi) Should identified control monuments no longer be found to exist, surveyor shall notify USC and utilize the next most appropriate monuments to assure a minimum of three monuments are captured in creating a project survey.
      - vii) Should an existing monument be removed by a Project's construction activities, it is the responsibility of the project to replace, and reset the monument in its original position, and provide a new survey with final horizontal and vertical control.

#### 2. Utility As-Built Surveys:

## USC DESIGN GUIDELINES

- a) To be performed by a University approved California licensed Land Surveyor.
- b) Capture all existing exposed utilities and installed new utilities.
  - i) Refer to Utility Management Attribute Matrix for minimum required survey attributes – Attached.
- c) Complete the Request for USC Utility As-Built Survey Form – Attached.
- d) Project Engineer to verify utility as-built survey provided and coordinate with the University Project Manager.
- e) Complete utility as-built surveys in ACAD format and submit to University Project Manager.
- f) Utility As-Built Surveys do not replace the project requirement for contractor provided red-lines.
- g) Horizontal, Vertical and EPOCH control guidelines are as follows:
  - i) A network of survey control monuments with Northing, Easting, and Elevation values has been established on the USC University Park Campus. All surveys, engineering plans, and architecture plans shall be tied to a minimum of three such monuments, the actual values used for such monuments, and the Epoch used.
  - ii) The Vertical Datum for the Campus is the National Geodetic Vertical Datum of 1929, LA City year 1985 adjustment.
  - iii) The Horizontal Datum for the Campus is the North American Datum of 1983 (NAD83) HPGN California State Plane Coordinate System of 1983 (CCS83) Zone 5 (0405).
  - iv) The two following Epochs (adjustments) of said CCS83 are in use on the Campus.
    - (1) Legacy Use (for older and some current plans): 1991.35 Epoch
    - (2) Current and Future Use: 1995.0 Epoch.
  - v) The Campus Control Recorded Survey Map provided herein clearly shows the Horizontal (both Epochs) and Vertical (NGVD29-LA City 1985) values for each Campus Control Monument.
  - vi) Should identified control monuments no longer be found to exist, surveyor shall notify USC and utilize the next most appropriate monuments to assure a minimum of three monuments are captured in creating a project survey.
  - vii) Should an existing monument be removed by a Project's construction activities, it is the responsibility of the project to replace, and reset the monument in its original position, and provide a new survey with final horizontal and vertical control.

- B. Other USC Facilities Including The Health Science Campus (except Catalina Campus)
  - I. Purpose: USC preferences and requirements are indicated in this document.
  - II. New campus surveys to be coordinated with and tied into the HSC Mapping Control Survey, where one exists.
    - 1. Topographic Design Surveys:
      - a) To be recorded with Los Angeles County Recorder's Office and performed by a California licensed Land Surveyor.



## USC DESIGN GUIDELINES

- b) Request and integrate available recent topographic design surveys and aerials from University Project Manager.
- c) Project Civil Engineer to field verify and investigate topographic design survey provided. Updated survey to be provided to the University Project Manager.
- d) See table below for a list of topographic design survey requirements.
- e) Horizontal and Vertical control guidelines are as follows:
  - i) The Vertical Values for the Campus are based upon North American Vertical Datum of 1988 (NAVD1988) utilizing City of Los Angeles Benchmarks
  - ii) The Horizontal Datum for the Campus is State Plane Coordinates, California Coordinate System, Zone 5, based on NAD83 (NSRS2007)

### 2. Utility As-Built Surveys:

- a) To be performed by a University approved California licensed Land Surveyor.
- b) Capture all existing exposed utilities and installed new utilities.
  - i) Refer to Utility Management Attribute Matrix for minimum required survey attributes – Attached.
- c) Complete the Request for USC Utility As-Building Survey Form – Attached.
- d) Project Engineer to verify utility as-built survey provided and coordinate with the University Project Manager.
- e) Complete utility as-built surveys in ACAD format and submit to University Project Manager.
- f) Utility As-Built Surveys do not replace the project requirement for contractor provided red-lines.
- g) Horizontal and Vertical control guidelines are as follows:
  - i) The Vertical Values for the Campus are based upon North American Vertical Datum of 1988 (NAVD1988) utilizing City of Los Angeles Benchmarks
  - ii) The Horizontal Datum for the Campus is State Plane Coordinates, California Coordinate System, Zone 5, based on NAD83 (NSRS2007)

C. Any work in Catalina Campus to be coordinated with USC.

D. BIM

- 1. Where a project intends to model systems within and/or adjacent to a building, and is required to follow the USC BIM Guidelines, through coordination with the project surveyor, the appropriate control benchmarks shall be utilized to establish a properly geospatially referenced base point, for which all models associated with the project are to be tied to.

## USC DESIGN GUIDELINES

- E. The following table summarizes the types of particular requirements identified within this section for all USC Campuses unless noted otherwise:

<b>Topographic Design Survey</b>	
<b>Requirements Listed</b>	<b>Preferences Listed</b>
<ol style="list-style-type: none"> <li>1. Survey shall be drawn using the Universal Coordinate System (UCS).</li> <li>2. Drawings shall note all dimensions and elevations in 1"=20' scale.</li> <li>3. Show north arrow and locate north to the top of page.</li> <li>4. Include legend of symbols and abbreviations.</li> <li>5. Spot elevations on hard surfaces shall be to the nearest 0.01'; spot elevations on other surfaces shall be to the nearest 0.10'.</li> <li>6. Show boundary and easements (based on client supplied title report).</li> <li>7. State elevation datum, based on local standard.</li> <li>8. Existing buildings with finished floor at all entries and building corners (including adjacent buildings).</li> <li>9. Fences and walls (including top and base of wall elevations).</li> <li>10. All Existing surface features, including pavement type and striping of parking lots.</li> <li>11. One foot contours over entire map.</li> <li>12. Spot elevations at all surface features and at a 20' grid.</li> <li>13. Street sections at 25' on center (where occurs) including center line, flow line, face of curb, top of curb, back of walk, including far side of street. Include striping.</li> <li>14. Building overhangs.</li> <li>15. Inverts at catch basins, manholes, and cleanouts.</li> <li>16. All Utility meters, tanks, valves, hydrants, pull boxes, etc.</li> <li>17. All trees of 2' trunk diameter and greater. Include drip line and tree type.</li> </ol>	<ul style="list-style-type: none"> <li>• Survey information to extend beyond specific limit of project site to capture nearest major street intersections</li> </ul>

**USC DESIGN GUIDELINES**

<b>Utility As-Built Survey</b>	
<b>Requirements Listed</b>	<b>Preferences Listed</b>
<ul style="list-style-type: none"><li>• Refer to attached Utility Management Attribute Matrix</li></ul>	

# USC DESIGN GUIDELINES

## 2. PROCEDURAL REQUIREMENTS

A. None.

# USC DESIGN GUIDELINES

## REQUEST FOR USC UTILITY AS-BUILDING SURVEY

PORTION TO BE FILLED OUT BY USC		
APPLICANT:		
TELEPHONE NO.:		EMAIL ADDRESS:
USC PROJECT#:		
PROJECT NAME:		
PROJECT ADDRESS:		
UTILITIES TO BE SURVEYED:		
DESIRED DATE FOR SURVEY WORK:		
MAX ESTIMATED SITE VISITS:		
CONTRACTOR:		CELL PHONE NO:
REMARKS:		
ATTACHMENTS:	<input type="checkbox"/> CURRENT SET OF PLAN	<input type="checkbox"/> VICINITY MAP
DATE:		SIGNED:

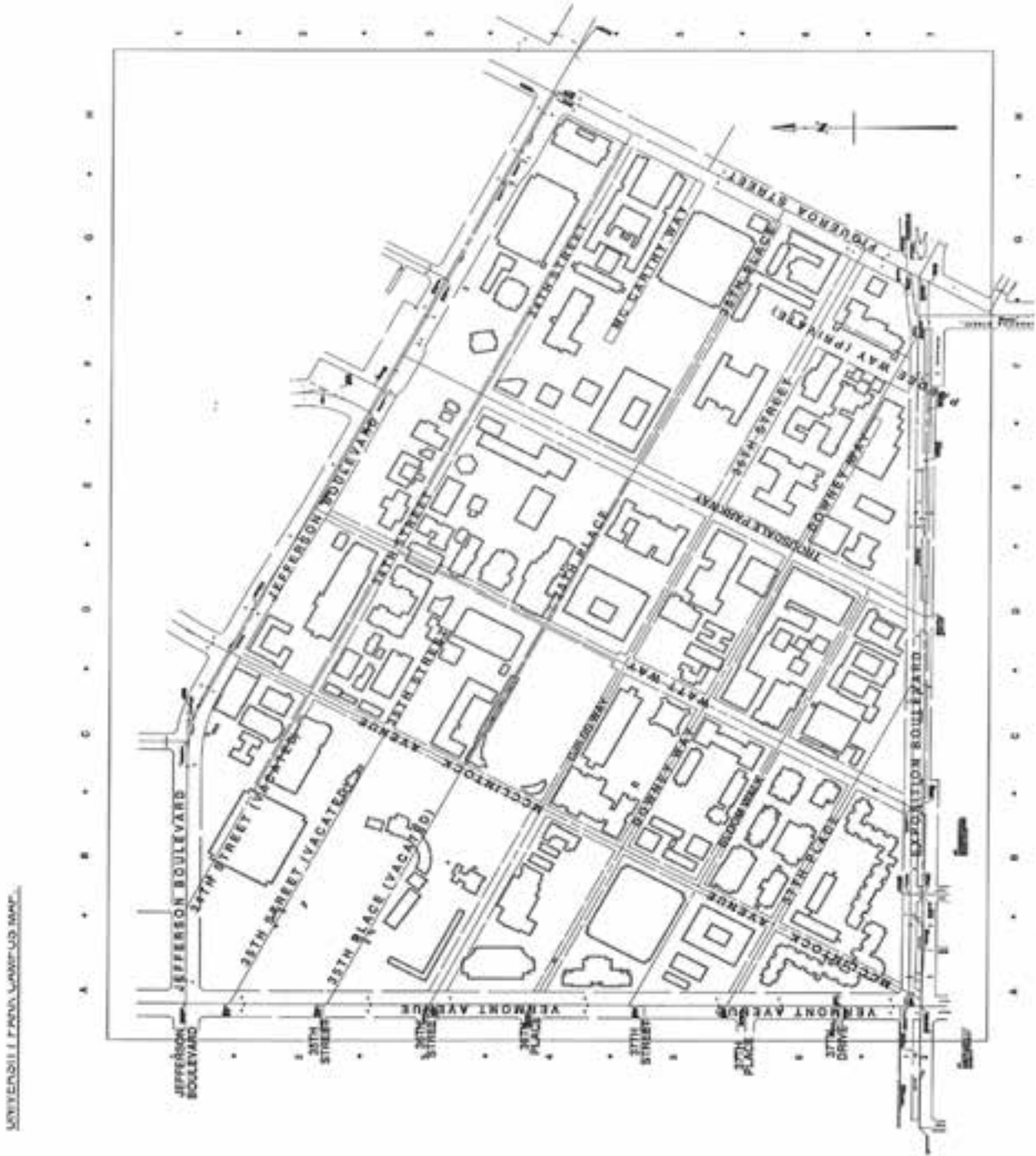
PORTION TO BE FILLED OUT BY SURVEYOR		
ON SITE SURVEY WORK COMPLETED ON:		
FILE SENT TO CIVIL ENGINEER ON:		
CAD FILE NAME:		
INVOICE #:		
REMARKS:		
ATTACHMENT:	<input type="checkbox"/> SURVEY CAD FILE	
DATE:		SIGNED:

PORTION TO BE FILLED OUT BY CIVIL ENGINEER		
USC PO#		JOB#
UPDATED SURVEY SENT TO USC ON:		
REMARKS:		
ATTACHMENT:	<input type="checkbox"/> SURVEY CAD FILE	
DATE:		SIGNED:

USC to Cc: jose@fms.usc.edu when sending form out

# USC DESIGN GUIDELINES

## USC UPC CAMPUS MAP



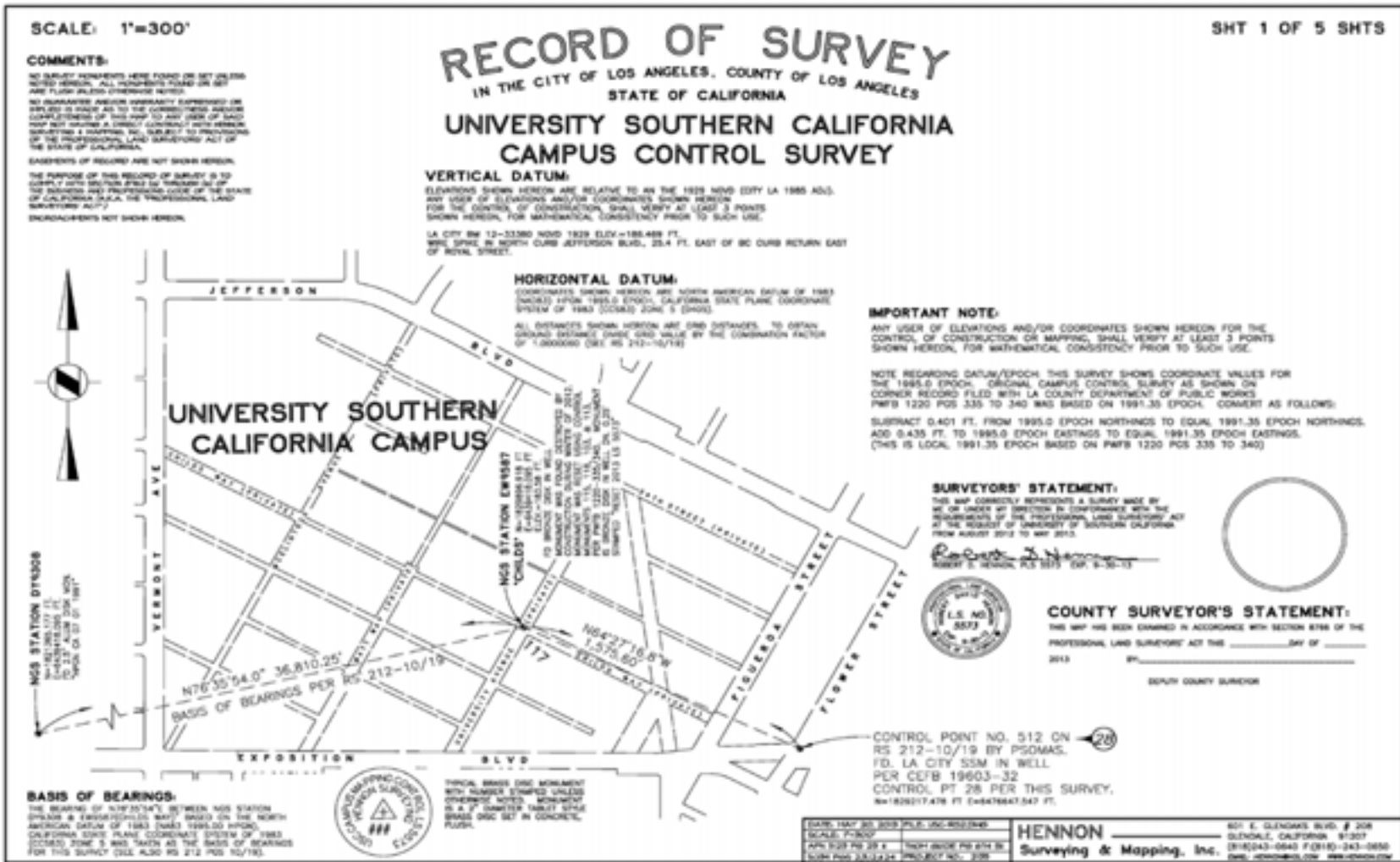
# USC DESIGN GUIDELINES

UTILITY MANAGEMENT ATTRIBUTE MATRIX										
	E	SD	S	DW	CHW	STM	HHW	RW	G	TEL
<b>Utility General</b>										
Center of Manhole/Vault Lid	X	X	X			X				X
Bottom of Manhole/Vault	X	X	X			X				X
Manhole/Vault Dimensions	X	X	X			X				X
Center of Valve Lid				X	X		X	X	X	
Center of Clean-Out Lid		X	X							
Top of Pipe Depth		X	X	X	X	X	X	X	X	
Bottom of Pipe Depth (Invert)		X	X	X	X	X	X	X	X	
Pipe Outside Diameter		X	X	X	X	X	X	X	X	
Pipe Material (if Known)		X	X	X	X	X	X	X	X	
Top of Enclosure Depth	X	X	X		X	X	X			X
Bottom of Enclosure Depth (Invert)	X	X	X		X	X	X			X
Enclosure outside dimensions	X	X	X		X	X	X			X
Enclosure Material	X	X	X		X	X	X			X
Underground Valve Locations				X	X	X	X	X	X	
Building Point of Entry	X	X	X	X	X	X	X	X	X	X
Change in elevation > 6" (new invert outside vault)	X	X	X	X	X		X	X	X	X
Date of Construction (by segment)	X	X	X	X	X	X	X	X	X	X
<b>Utility Specifics</b>										
# of Conduits	X									X
Conduit Diameter	X									X
Lateral Connection Locations		X	X	X	X	X	X	X	X	
Hydrant Location				X						
Hydrant Connection Locations				X						
Catch Basin / Collection System Location		X								
Catch Basin / Collection System Dimensions		X								
Building Transformer Location (if Outdoors)	X									
Layer Color	<span style="color: red;">RED</span> <span style="color: green;">GREEN</span> <span style="color: lightgreen;">GREEN</span> <span style="color: blue;">BLUE</span> <span style="color: cyan;">TBD</span> <span style="color: cyan;">TBD</span> <span style="color: cyan;">TBD</span> <span style="color: purple;">PURPLE</span> <span style="color: yellow;">YELLOW</span> <span style="color: orange;">ORANGE</span>									
	Other (Non-Utility Related)									
Tree Drip Lines										
Center of Tree										

**LEGEND**

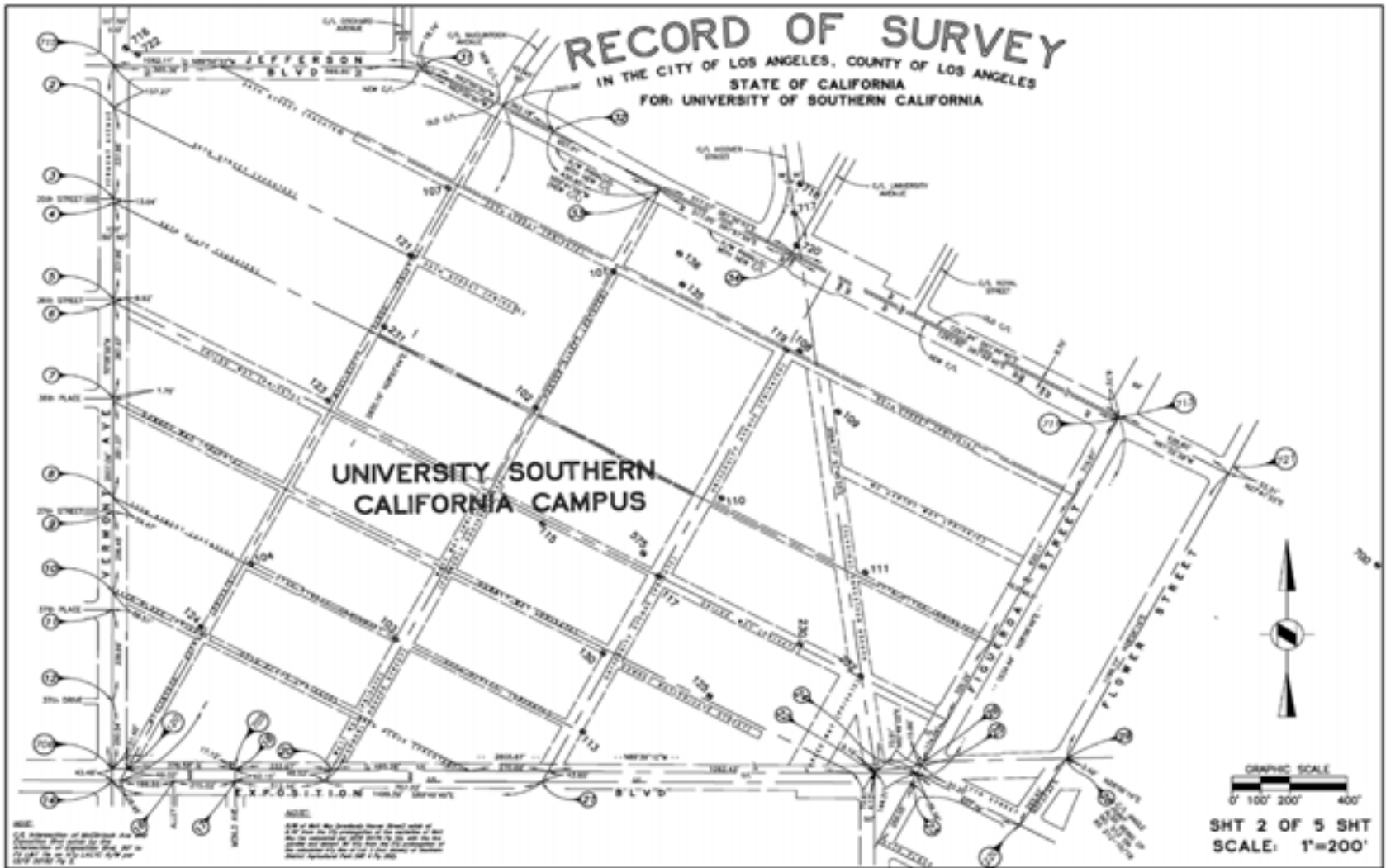
- E - Electrical (High Voltage)
- SD - Storm Drain
- S - Sewer
- DW - Domestic Water
- CHW - Chilled Water
- STM - Steam
- HHW - Heating Hot Water
- RW - Reclaimed Water
- G - Gas
- TEL - Telephone / Data

# USC DESIGN GUIDELINES





# USC DESIGN GUIDELINES









# USC DESIGN GUIDELINES

END OF DOCUMENT

# USC DESIGN GUIDELINES

## 03 4813 PRECAST CONCRETE BOLLARDS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements for the following are described in this document:
1. Precast concrete bollards – decorative
  2. Precast concrete bollards – non-decorative
- B. The following table summarizes the types of particular requirements identified within this Section:

Requirements Listed	Preferences Listed	Disallowed Items Listed	Items Requiring Commissioning /Testing
X	X	X	

### 2. PROCEDURAL REQUIREMENTS

### 3. PRODUCT REQUIREMENTS

- A. Decorative Bollards
1. Manufacturers:
    - a) Required: Steinberg Lighting Co.
    - b) Preferred: None
    - c) Disallowed: All Others
  2. Component Characteristics:
    - a) Style: Parkside Unlit Bollard, Modified Oxford – USC Customized
    - b) Model Number 6404 FP-QRB-38"-ABZ
    - c) Finish: Dunn/Edwards "Weathered Brown"
    - d) Bollard welded for single unit construction
    - e) 7" diameter fluted shaft, .188 wall thickness, 6061-T6 structural grade aluminum
    - f) Access door secured with stainless steel allen head screws
    - g) Cable routed through slot in front of base
    - h) 18' diameter base
    - i) 3" diameter shaft, 23" from bottom of bollard to end of shaft, with key
    - j) 38" tall from base to top
- B. Non - Decorative Bollards
1. Manufacturers:
    - a) Required: None
    - b) Preferred: FairWeather Site Furnishings (or equal)
    - c) Disallowed: None
  2. Component Characteristics:

## USC DESIGN GUIDELINES

- a) Part Number Model B-2, 6" Removal Bollard, No Collars
- b) Yellow finish
- c) Fabricated with 5" schedule 10 steep pipe and a schedule 40 weld cap welded and ground smooth. Steel conforms to ASTM A53
- d) 6" diameter shaft with lock tab
- e) Cable routed through lock tab
- f) 30"- 48" tall from base to top (as determined on a project basis)

C.

### 4. INSTALLATION REQUIREMENTS

#### A. Decorative Bollards

- 1. Concrete: Approximately 12" diameter and 24" deep to accommodate shaft
- 2. Cable must be taped in an upright position
- 3. End of 3 1/2" diameter tube shall be even with grade
- 4. Slot shall be clear of concrete and all other debris

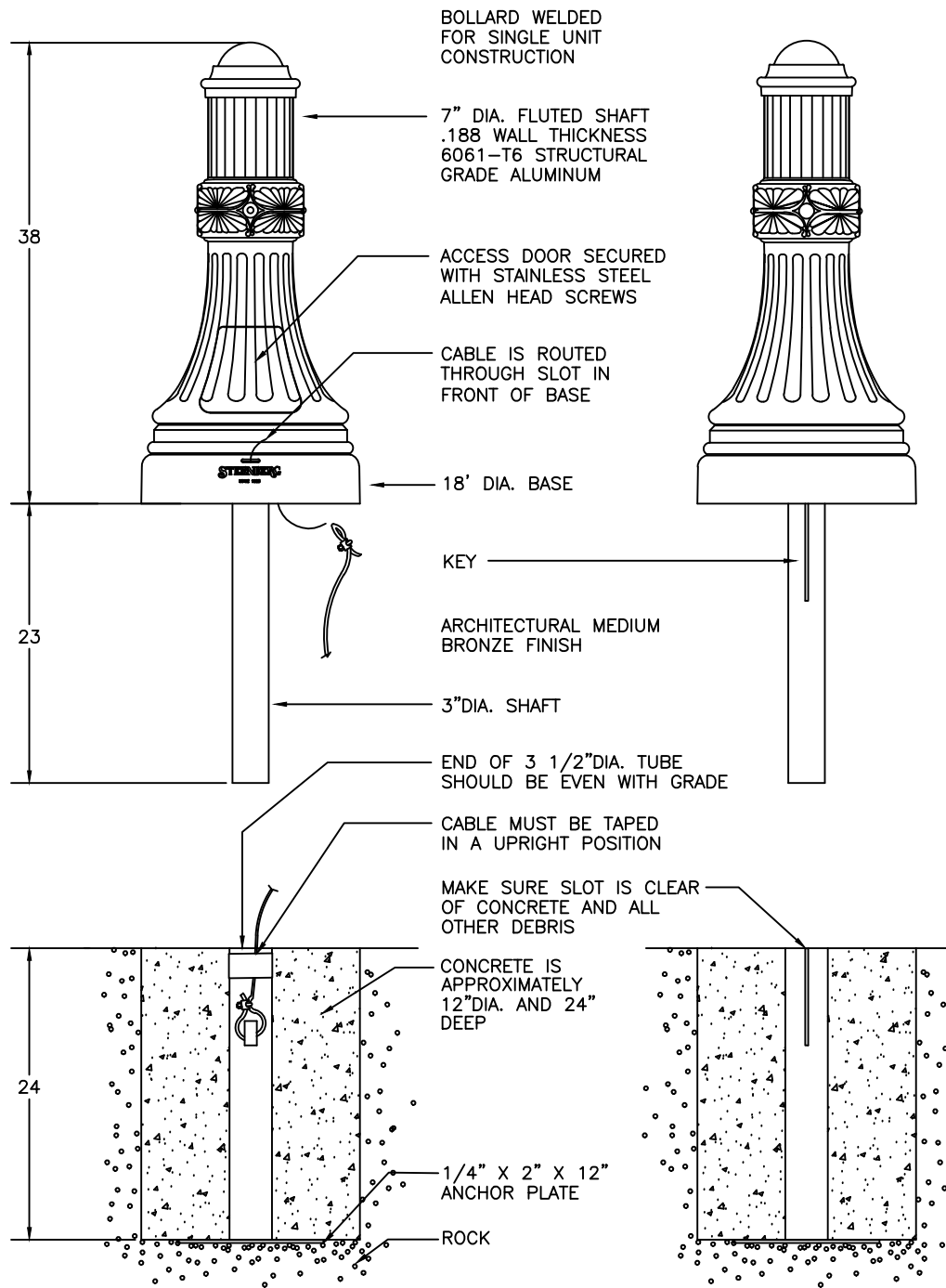
#### B. Non-Decorative Bollards

- 1. Concrete: Approximately 12" diameter and 24" deep to accommodate shaft
- 2. Cable must be taped in an upright position
- 3. Slot shall be clear of concrete and all other debris

### 5. EVALUATION OR COMMISSIONING – Not Used

### 6. Exhibits

- A. Standard Assembly Bollard – Decorative
- B. Standard Assembly Bollard – Non Decorative

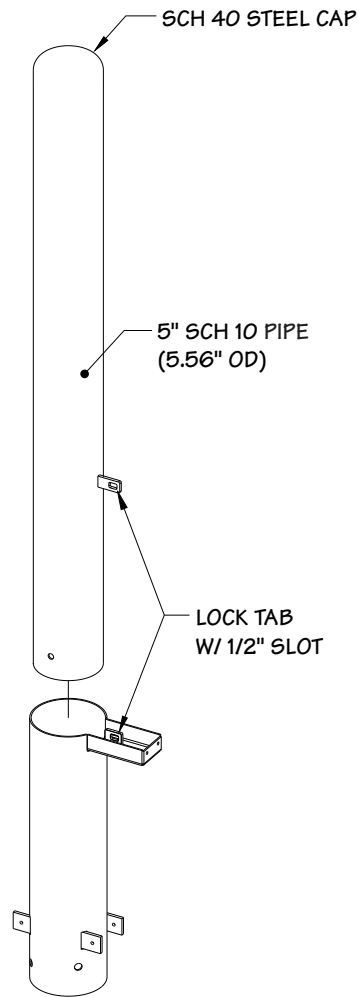
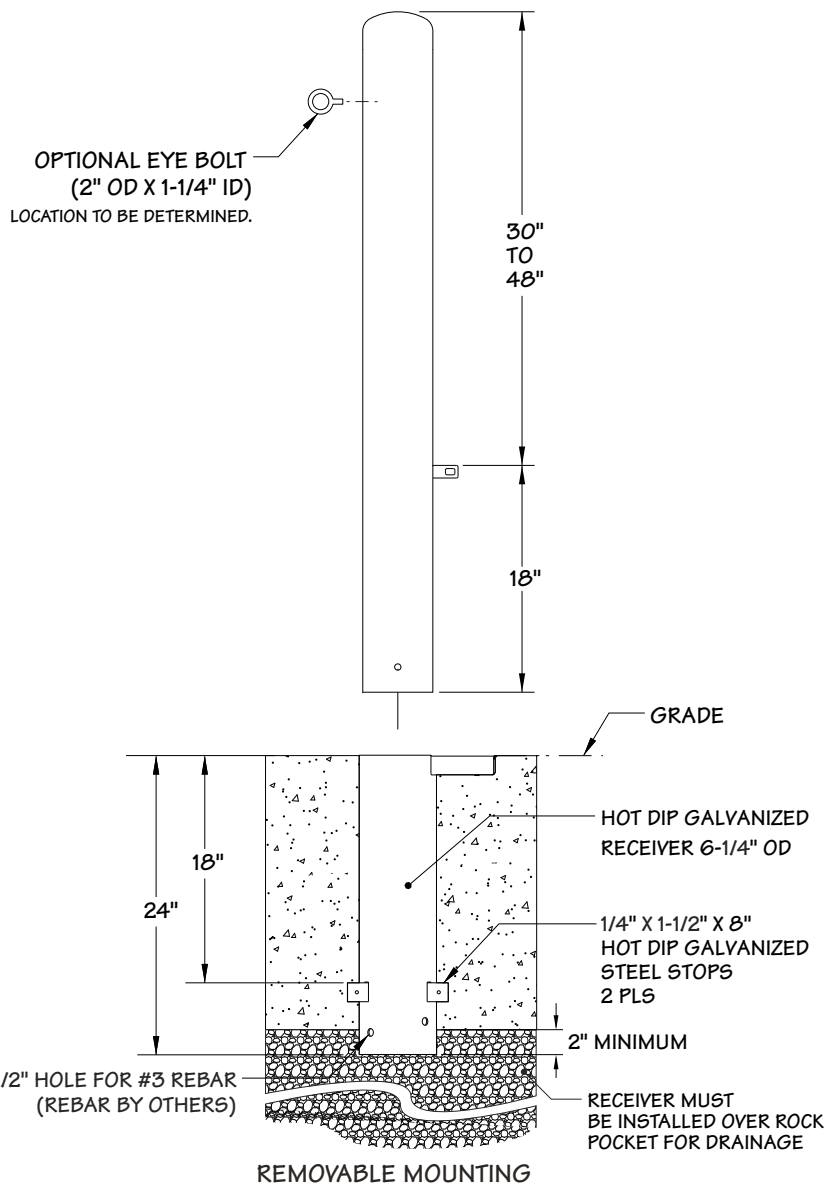


**USC CAMPUS STANDARD ASSEMBLY**

**BOLLARD 6201B-FP7-30"**

Contact:  
 Prudential Lighting Products  
 Crissy Cosci  
 1737 E 21st Street  
 Los Angeles, CA 90058  
 213-477-1643  
 01/10/2013





## SPECIFICATIONS

### MATERIAL

The B-2, 6" bollard shall be fabricated with 5" sch. 10 steel pipe (5.56" OD) and a schedule 40 weld cap welded and ground smooth. Steel shall conform to ASTM A53.

The in ground receiver, for **removable bollard only** shall be fabricated with 6-1/4" OD steel sleeve welded to a 3" x 5" lockwell.

### PROTECTIVE COATINGS

**Powder Coating:** Following fabrication bollards shall be cleaned and treated with an iron phosphate process prior to the coating application. The protective coatings shall be either polyester or polyester TGIC powder. Following application the parts shall be baked until properly cured. The coating shall be a minimum of 4 mils thick on all surfaces.

**Options for finish:** Corrosion resistant undercoat, strongly recommended

**Hot Dip Galvanizing on Receivers:** Following fabrication, the receivers shall be hot dip galvanized to standard ASTM A123, 3 to 4 mils thick.

**Note:** Unless otherwise specified, bollards shall be powder coated a standard FairWeather color.

**Options:** Sch 40 or Sch 80 pipe, eye bolts  
On removable bollards: receiver cover, lock well cover and padlock.

Mounting: Surface, removable or embed

### NOTE:

1. Depth and diameter of installation hole may vary with soil conditions. Consult project engineer for correct dimensions.
2. **REMOVABLE BOLLARDS ONLY:** Receiver must be installed in drainage rock. No crushed or minus rock  
Due to soil conditions the amount of drainage needed could vary from as little as 8 inches to 2 feet or more. Improper installation will void the warranty

REV 1-02-13

## Model B-2, 6" Removable Bollard, No Collars

### FairWeather Site Furnishings

360-895-2626 or Toll Free 800-323-1798

Port Orchard, Washington

©1999-2013 Leader International Corporation, FairWeather Site Furnishings division  
Notice: These products are proprietary. Numerous designs are patented or patent pending under Leader Manufacturing, Inc.

**USC DESIGN GUIDELINES**

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 05 0513 APPLIED EXTERIOR COATINGS FOR METAL

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements for exterior metal coatings are described in this Section.
1. For other related requirements, refer to Section 08 0000 "Openings" for exterior window, door and storefront finishes.
- B. The following table summarizes the types of particular requirements identified within this Section:

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
X			

### 2. PROCEDURAL REQUIREMENTS

- A. Quality Assurance Requirements (Beyond Standard One-Year Warranty):
1. Required: Twenty-year warranty for factory-applied PVDF finish coat on aluminum.

### 3. PRODUCT REQUIREMENTS

- A. Exterior Steel Fabrications:
1. Base Coat:
    - a) Required: Galvanized.
  2. Finish Coat:
    - a) Required: Field- or shop-applied epoxy polyurethane high-performance coating system over galvanized coating.
- B. Aluminum Flashing, Exposed (Visible) and Semiexposed:
1. Finish Coat:
    - a) Required: Coil-coated PVDF coating system; factory-applied.

### 4. INSTALLATION REQUIREMENTS – Not Used

### 5. EVALUATION or COMMISSIONING Not Used

END OF DOCUMENT

# USC DESIGN GUIDELINES

## 07 0000 ROOFING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements for roofing assemblies, including roof accessories, are described in this Section.
1. For other related requirements, refer to the following documents:
    - a) Section 01 0000 "General Requirements" for mockup requirements.
    - b) Section 05 0513 "Applied Exterior Coatings for Metal" for finishing of exposed metal flashing.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design Considerations for Roofing:
1. Required: Meet with USC roofing consultant to determine specific project needs for roofing systems.
  2. Steep Slope Roofing Type/Material:
    - a) Required: Clay tile.
  3. Flat and Low-Slope Roofing Type/Material:
    - a) Required: Determined on a per-project basis.
    - b) Preferred: Polyvinyl-chloride (PVC) roofing system, single ply.
- B. Quality Assurance Requirements for Clay Tile Roofing:
1. Special Warranty (from Manufacturer): Standard form in which manufacturer agrees to repair or replace clay roof tiles that fail in materials within specified warranty period.
    - a) Materials-Only Warranty Period: 50 years from date of Substantial Completion.
  2. Special Project Warranty (from Installer): Determined on a per-project basis.
    - a) Warranty Period: Determined on a per-project basis.
- C. Quality Assurance Requirements for Membrane Roofing:
1. Special Warranty (from Manufacturer): Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
    - a) Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof pavers, and other components of roofing system.
    - b) Warranty Period: 20 years from date of Substantial Completion.

## USC DESIGN GUIDELINES

2. Special Project Warranty (from Installer): Determined on a per-project basis.
  - a) Warranty Period: Determined on a per-project basis.

### 3. PRODUCT REQUIREMENTS

- A. Clay Tile Roofing:
  1. Manufacturers:
    - a) Preferred:
      - a) Clay Forever, LLC.
      - b) Claymex Brick and Tile, Inc.
      - c) Deleo Clay Tile.
      - d) D'Hanis Brick & Tile Company.
      - e) Gladding, McBean; a division of PABCO Building Products, LLC.
      - f) International Roofing Products, Inc.
      - g) Ludowici Roof Tile.
      - h) M.C.A. (Maruhachi Ceramics of America, Inc.).
      - i) US Tile.
      - j) Zion Tile Corporation.
  2. Tile Color and Pattern:
    - a) Required: Color mix is dependent on the colors of surrounding clay tile roofs, and may include tile colors utilized on adjacent buildings.
- B. Polyvinyl-chloride (PVC) Roofing:
  1. Manufacturer and Product:
    - a) Required: Determined on a per-project basis.
    - b) Preferred: Sarnafil, Inc.; PVC roofing membrane, single ply, 60 mil thickness.
- C. Rooftop Equipment:
  1. Required: Opaque screening for rooftop equipment, if visible from street or from other surrounding buildings.
- D. Roof Access: Type of roof access depends on equipment located on roof.
  1. Preferred: Elevator access, if routine maintenance is required for equipment located on a roof.
    - a) Access by stair may be acceptable, as determined on a per-project basis.
- E. Roof Drainage: Discharge at downspouts and overflows.
  1. Preferred: Sealed pipe connection for roof drain water into the drainage system.
  2. Disallowed: Discharging rooftop water onto splash blocks, or discharging rooftop water at grade.

### 4. INSTALLATION REQUIREMENTS – Not Used

### 5. EVALUATION AND COMMISSIONING

- A. Items and Systems for Evaluation and Commissioning: Determined on a per-project basis.
  1. Documentation: Determined on a per-project basis.

## **USC DESIGN GUIDELINES**

2. Testing Protocols: Determined on a per-project basis.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 08 0000 OPENINGS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are described in this document for the following.
  - 1. Exterior Openings
    - a) Exterior doors (other than storefront doors).
    - b) Exterior windows.
    - c) Exterior storefronts.
    - d) Exterior Specialty Doors.
    - e) Glazing for exterior windows, doors and storefronts.
    - f) Exterior Pedestrian Gates.
  - 2. Interior Openings
    - a) Interior doors (other than storefront and all-glass doors).
    - b) Interior windows.
    - c) Interior storefronts.
    - d) Interior fire-rated glass and framing systems
    - e) Interior Integrated Door Opening Assemblies.
    - f) Interior Specialty Doors.
    - g) Glazing for interior windows, doors and storefronts.
- B. For other related requirements, refer to *USC Design Guidelines* Div 01 0000 "General Requirements" for exterior wall mockups.
- C. For renovation projects Architects/Design Professionals are to properly investigate proper wall ratings and not to default to labeled openings.
- D. All alternative equals only shall be approved by USC Lock Shop Supervisor.
- E. Architects to investigate wall ratings
- F. The following table summarizes the types of particular requirements identified within this Section:

**USC DESIGN GUIDELINES**

<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Commissioning/ Testing</b>
<p>Exterior/Interior Hollow Metal Doors/Frames - Curries</p>	<p>Ceco, Door Components, Hollow Metal Xpress, Security Metal Products, Stiles Custom Metal, or other member of Steel Door Institute (SDI). Minimum 16-gauge frames. Exterior minimum 16-gauge steel full welded seamless edge stiffened doors. Interior minimum 18-gauge steel stiffened doors</p>	<p>Any Wood door, Steelcraft and all other non SDI hollow metal</p>	<p>Field Quality Control Inspection during Close Out Phase</p>
<p>Interior Hollow Metal Doors with "Wood Like" Face Skins at Ground Floor Stairs Only – Curries/ASSA ABLOY "CURRIStain"</p>	<p>Ceco/ASSA ABLOY "Madera", Steelcraft/Allegion "Graintech". Interior minimum 18-gauge steel stiffened doors</p>	<p>Any Wood door, all other hollow metal manufacturers</p>	<p>Field Quality Control Inspection during Close Out Phase</p>



## USC DESIGN GUIDELINES

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
Interior Knock-Down Aluminum Frames (Western Integrated)	Frameworks, Wilson Partitions	All Others	Field Quality Control Inspection during Close Out Phase
Interior Knock-Down Pressed Steel Door Frame (Timely)	Rediframe	All Others	Field Quality Control Inspection during Close Out Phase
Interior Wood Doors (Eggers)	Algoma, VT, or approved equal	All others	Field Quality Control Inspection during Close Out Phase
Interior Integrated Door Opening Assemblies – “Rite Door” by Adams Rite, an ASSA ABLOY Group Company	None	“InPact” by Allegion, Syntegra & “Total Door” by Openings, and all others without prior approval of Lock Shop Supervisor	Field Quality Control Inspection during Close Out Phase
Interior fire rated glass and framing systems	Use Hollow Metal doors with fire-rated glazing. Alternative system to be submitted for approval by USC Lock Shop	SaftiFirst, TGP/Fireframes (Technical Glass Products), Vetrotech USA/Saint-Gobain and all others	Field Quality Control Inspection during Close Out Phase
Interior All-Glass Pivoting Doors with Exit Devices/No Access Control allowed	N/A	All brands not allowed on any application	N/A

**USC DESIGN GUIDELINES**

<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Commissioning/ Testing</b>
<p>Interior All-Glass Pivoting Doors with patch fit lock housings; Corbin-Russwin (UPC) or Yale (HSC) mortise</p>	<p align="center">None</p>	<p align="center">All brands not allowed on any application</p>	<p align="center">N/A</p>

## USC DESIGN GUIDELINES

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
All-Glass Sliding Doors with patch fit lock housings; Trimco or Inox mortise locks – Interior Only	None	Accurate, AD Systems (Aurora), CR Laurence (CRL), DIRTT, FSB, Steelcase, and all others and any application	Field Quality Control Inspection during Close Out Phase

## USC DESIGN GUIDELINES

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
Sliding/Pocket/Barn Door systems	K.N. Crowder Catch'n'Close. KN Crowder "Crowder Slide" Sliding Door Systems for access control and/or acoustical applications. Approval by USC Lock Shop Supervisor for any other applications	AD Systems (Aurora), CR Laurence (CRL), DIRTT, Hafele, Hawa, Johnson, Pemko/Henderson, Steelcase, Western Integrated, Wilson Partitions, and all others and any application without prior approval of USC Lock Shop Supervisor	Field Quality Control Inspection during Close Out Phase

## USC DESIGN GUIDELINES

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
Interior Storefront Doors – Wide stile Kawneer	Approved equals with wide stile	Balanced Doors, All others and Narrow Stile	Field Quality Control Inspection during Close Out Phase
Exterior/Interior Specialty Doors/Frames by Special-Lite SL-15 Monumental with 4-3/4-inch stile, SL-484 12-inch mid-panel and SL-88 flush pull	Special-Lite SL-17/SL-20 Series for special applications as approved by USC Lock Shop Supervisor	All Others	Field Quality Control Inspection during Close Out Phase
Exterior/Interior Specialty Doors not per BOD must be approved by Lock Shop Supervisor	None	All Others	Field Quality Control Inspection during Close Out Phase
Exterior & Interior Specialty (STC) Acoustical Doors/Frames by Krieger Steel	Overly, Security Metal Products, Stiles Custom Metal	All Others	Field Quality Control Inspection during Close Out Phase

## USC DESIGN GUIDELINES

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
Exterior pedestrian gates with door hardware	Design with head section to support University Standard surface door closer, panic device, mortise lock and electrical requirements.	All designs to be reviewed by USC Lock Shop	Field Quality Control Inspection during Close Out Phase
Automatic Door Operators and Bollards to be specified under Section 087113	Besam SW200i and Horton equal only. LCN for student housing apartment entries only	All Others	Field Quality Control Inspection during Close Out Phase
Door and Frame Fire Labels	Intertek-Warnock Hersey, QAI Laboratories, Underwriters Label	Commonwealth, Guardian, and all Others	Field Quality Control Inspection during Close Out Phase
Exterior/Interior Moveable Wall Systems	NanaWall 840 Series with prior approval of Lock Shop Supervisor	All others without prior approval of Lock Shop Supervisor	Field Quality Control Inspection during Close Out Phase

### 2. PROCEDURAL REQUIREMENTS

- A. Quality Assurance Requirements (Beyond Standard One-Year Warranty):
1. Required: Terms and warranty periods will be determined on a per-project basis and for the following:
    - a) Door and door frame assemblies.
    - b) Window and window frame assemblies.
    - c) Motorized window controls (if any).
    - d) Storefront system, including components, installation and integrated assembly.
    - e) Special finish warranty for steel and aluminum finishes.
    - f) Coated-glass.
    - g) Insulating glass.

### 3. PRODUCT REQUIREMENTS

- A. Steel Door Manufacturers:

## USC DESIGN GUIDELINES

1. Preferred:
  - a) Ceco Door Products; an ASSA ABLOY Group company.
  - b) Curries, an ASSA ABLOY Group company.
  - c) Door Components, Inc.
  - d) HMF Express
  - e) Security Metal Products, an ASSA ABLOY Group company.
  - f) Stiles Custom Metal
  - g) Equal submitted for approval must be an SDI member.
- B. Interior Knock-Down Pressed Steel Door Frames
  1. Preferred:
    - a) RediFrame, 18-Gauge
    - b) Timely, 18-Gauge
    - c) Approved Equal
  2. Above frames shall have prior approval of University Lock Shop Supervisor.
- C. Wood Door Manufacturers:
  1. Preferred:
    - a) Algoma
    - b) Eggers
    - c) VT
    - d) Approved Equal
- D. Aluminum Window Manufacturers:
  1. Preferred:
    - a) EFCO Corporation; a Pella company.
    - b) Fleetwood Windows & Doors.
    - c) TRACO.
    - d) YKK AP America Inc.
    - e) Approved Equal
- E. Steel Window Manufacturers:
  1. Preferred:
    - a) A & S Window Associates, Inc.
    - b) Crittall Windows Ltd.
    - c) Hope's Windows, Inc.
    - d) Torrance Steel Window Co., Inc.
    - e) Approved Equal
- F. Wood Window Manufacturers:
  1. Preferred:
    - a) JELD-WEN, Inc.
    - b) Marvin Windows and Doors.
    - c) Pella Corporation.
    - d) Weather Shield Mfg., Inc.
    - e) Approved Equal
- G. Interior Aluminum Storefront Manufacturers:
  1. Preferred:
    - a) Arcadia, Inc.
    - b) EFCO Corporation; a Pella company.
    - c) Kawneer North America.
    - d) TRACO.

## USC DESIGN GUIDELINES

- e) Approved Equal
- H. Interior Knock-Down Aluminum Door Frames:
  - 1. Preferred:
    - a) Western Integrated
    - b) Wilson Partitions
    - c) Approved equal
- I. Specialty Door Manufacturers:
  - 1. Preferred exterior and interior Acoustical STC or Ballistic Doors/Frames:
    - a) Krieger Steel.
    - b) Overly.
    - c) Security Metal Products.
    - d) Approved Equal
  - 2. Preferred exterior Fiberglass Composite Door Manufacturer:
    - a) Special-Lite, Inc.
  - 3. Preferred interior acoustical and/or Access Control Sliding Door Systems:
    - a) Serenity Sliding Door Systems
    - b) Approved Equal.
- J. Material and Finish, General:
  - 1. Required: Determined on a per-project basis.
  - 2. Preferred: Match existing, if any, or match as closely as possible the aesthetics of similar components in nearby buildings.
- K. Exterior Doors (Other than Storefront Doors):
  - 1. Material:
    - a) Preferred: Steel.
    - b) Disallowed: Wood.
- L. Exterior Window Types:
  - 1. Preferred: Fixed (non-operable).
    - a) Operable windows, if needed, will be determined on a per-project basis.
- M. Aluminum Finishes:
  - 1. Preferred: Clear anodic (anodized), AAMA 611, AA-M12C22A41, Class I, or thicker; or color PVDF 70 percent coating system, shop-applied.
- N. Steel Finishes:
  - 1. Required: Field- or shop-applied epoxy polyurethane high-performance coating system over galvanized coating.
- O. Glazing: For exterior windows, doors and storefronts.
  - 1. Required:
    - a) Float glass; ASTM C 1036, Type I, Quality-Q3, Class I (clear).
    - b) Low-e coated vision glass, meeting project-specific energy performance requirements.
  - 2. Preferred: Type to match existing, if any, in performance and appearance.
  - 3. Disallowed:
    - a) Tinted (colored) glass.
    - b) Mirrored glass.
    - c) Patterned or etched glass.
    - d) Plastic glazing.



## USC DESIGN GUIDELINES

### 4. INSTALLATION REQUIREMENTS

- A. Operable Windows: The need for operable windows will be determined on a per-project basis.
  - 1. Required: For installation of operable windows in buildings with HVAC control system, provide limiting controls for windows. Coordinate operator wiring requirements and electrical characteristics with building electrical system. Incorporate the following features and functions:
    - a) Limit devices and controls shall be programmable to interface with building HVAC system.
    - b) Controls shall have either preset or programmable setting to limit sash or ventilator opening to less than fully-open position.

### 5. EVALUATION or COMMISSIONING

- A. Items or systems requiring testing, evaluation, verification, or commissioning:
  - 1. Required: For wind and water penetration, and energy (thermal) transmittance, as determined on a per-project basis, for the following:
    - a) Storefront assemblies.
    - b) Windows, installed with glazing.
    - c) Doors and door frames, installed with glazing (if any).

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 08 7100 DOOR HARDWARE

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements for door hardware, including operating hardware, locks and cylinders, are described or referenced in this Section.
- B. Related Requirements:
  - 1. *USC Design Guidelines* Division 08 0000 "Openings" for windows, doors and storefronts.
- C. The following table summarizes the types of particular requirements identified within this Section:

**USC DESIGN GUIDELINES**

<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Commissioning/ Testing</b>

**USC DESIGN GUIDELINES**

<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Commissioning/ Testing</b>
Corbin-Russwin (UPC) or Yale (HSC) Mortise Locksets	Trimco and Inox mortise locks at sliding doors	All Others	Field Quality Control Inspection during Close Out Phase

**USC DESIGN GUIDELINES**

<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Commissioning/ Testing</b>
Yale R-5400LN Bored Locksets	None	All Others	Field Quality Control Inspection during Close Out Phase

**USC DESIGN GUIDELINES**

<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Commissioning/ Testing</b>
Corbin-Russwin IC Prep Cylinder Housings	ASSA, Best and Medeco, Schlage where required	All Others	Field Quality Control Inspection during Close Out Phase

## USC DESIGN GUIDELINES

<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Commissioning/ Testing</b>
Von Duprin PA98 Series Exit Devices	None	Von Duprin 33A/35A/55/88/99 Series and all others require USC Lock Shop approval	Field Quality Control Inspection during Close Out Phase

**USC DESIGN GUIDELINES**

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
<p>Besam SW200i or Horton equal Overhead surface Automatic Operators</p>	<p>LCN 4630/4640 series at interior Student Housing rooms only (Residence); or at UPC/HSC single occupant restroom and low traffic multi-occupant restrooms. HES Electric Strikes allowed on interior doors only without Lenel. Lenel doors must have electrified latch retraction.</p>	<p>Overhead Concealed and In-Ground Models disallowed. All Others require Lock Shop Supervisor approval</p>	<p>AAADM Certification</p>



## USC DESIGN GUIDELINES

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
LCN 4040XP Series Surface Door Closers	Norton 1601/1601BF at Student Housing rooms only (Residence)	All Others	Field Quality Control Inspection during Close Out Phase
Floor Closers	None Allowed	All Others	Field Quality Control Inspection during Close Out Phase

**USC DESIGN GUIDELINES**

<p align="center"><b>Requirements Listed</b></p>	<p align="center"><b>Preferences Listed</b></p>	<p align="center"><b>Disallowed Items Listed</b></p>	<p align="center"><b>Item Requiring Commissioning/ Testing</b></p>
<p>Access Control Hardware</p>	<p>Electrified hardware at new construction per above approved UPC/HSC/HSM locksets, or Von Duprin exit devices. Schlage AD400 Online only at retrofit in buildings without Lenel. Use of AD400 must be approved by Lockshop. ASSA ABLOY/Corbin Russwin Persona</p>	<p>Schlage AD200</p>	<p>Electrified hardware, AD400 under Field Quality Control Inspection during Close Out Phase; AD400 under Division 28</p>

**USC DESIGN GUIDELINES**

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
Sliding, Pocket and Barn Door Hardware	Hanging system shall be KN Crowder Catch'n'Close. Door hardware shall be Trimco Sliding Door Lock 1074-2USC-T01.Munich or Inox Sliding Door Lock PD9550-XGT202.Munich. KN Crowder "Crowder Slide" Sliding Door Systems for acoustical and/or	AD Systems (Aurora)/Allegion, DIRTT, Hager, Hafele, Hawa, Henderson-Pemko/ASSA ABLOY, Johnson, Rite Slide/ASSA ABLOY, Serenity Sliding Door Systems, Stanley, Steelcase, Western Integrated, Wilson Partitions, Accurate, and all others without	Field Quality Control Inspection during Close Out Phase

## USC DESIGN GUIDELINES

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
<p style="text-align: center;">Classroom Security Door Hardware at New &amp; Existing Hardwired Openings With Lenel &amp; Schlage AD400 WiFi Locks</p>	<p style="text-align: center;">SDC 434KLDURL2 Lockdown Button on inside of classroom with STI-6518 Flip Cover</p>	<p style="text-align: center;">All others without prior approval of Lock Shop Supervisor</p>	<p style="text-align: center;">Electrified hardware under Field Quality Control Inspection during Close Out Phase; under Division 28</p>

**USC DESIGN GUIDELINES**

<p align="center"><b>Requirements Listed</b></p>	<p align="center"><b>Preferences Listed</b></p>	<p align="center"><b>Disallowed Items Listed</b></p>	<p align="center"><b>Item Requiring Commissioning/ Testing</b></p>
<p align="center">Classroom Security Door Hardware Existing Openings With All Brands/Types Of Mechanical Classroom Function Locksets, Omnilocks &amp; Schlage AD200 Offline Locks</p>	<p>SDC 1500 Series Magnetic Lock, 602RF x RB12V4 Power Supply, 423MU Exit Button &amp; 434KLDURL2 Lockdown Button with STI-6518 Flip Cover on inside of room. SDC 700 Series Key Switch on outside of room. Field modify existing egress side mechanical operating</p>	<p>All others without prior approval of Lock Shop Supervisor</p>	<p>Electrified hardware under Field Quality Control Inspection during Close Out Phase; under Division 28</p>

## USC DESIGN GUIDELINES

<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Commissioning/ Testing</b>
Interlock	Contact USC Lock Shop for approval.	All others without prior approval of Lock Shop Supervisor	Electrified hardware under Field Quality Control Inspection during Close Out Phase; under Division 28

## USC DESIGN GUIDELINES

<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Commissioning/ Testing</b>
Delayed Egress	Contact USC Lock Shop for approval.	All others without prior approval of Lock Shop Supervisor	Electrified hardware under Field Quality Control Inspection during Close Out Phase; under Division 28

## USC DESIGN GUIDELINES

<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Commissioning/ Testing</b>
Roof Doors	Contact USC Lock Shop for approval	All others without prior approval of Lock Shop Supervisor	Electrified hardware under Field Quality Control Inspection during Close Out Phase; under Division 28



## USC DESIGN GUIDELINES

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
<p>Gate Hardware per Door Hardware Specifications 08 71 01, 08 71 02 &amp; 08 71 03</p>	<p>Keedex Welded Gate Boxes. D&amp;D Technologies SureClose Series or Locinox Mammoth Series Gate Pivot/Closer where no head exists.</p>	<p>All others without prior approval of Lock Shop Supervisor</p>	<p>Field Quality Control Inspection during Close Out Phase</p>

## USC DESIGN GUIDELINES

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
Electric Strikes at Restrooms Only with Automatic Operators where no Lenel exists	HES 8300/8500 Series	All other manufacturers	Field Quality Control Inspection during Close Out Phase

### 2. PROCEDURAL REQUIREMENTS

A. Project Meetings and Coordination:

## USC DESIGN GUIDELINES

1. Required: Coordinate door hardware requirements with the University Project Manager.
  - a. Preinstallation Conference: Conduct meeting on project site.
  - b. Keying Conference: Contractor shall schedule and conduct a meeting with the Architect, University Project Manager, University Lock Shop, and Architectural Hardware Consultant.
  - c. All rooms and offices to be locking or capable of locking to method defined by University standards.
  - d. All conference rooms to be locking unless within a lockable suite.
  
- B. B. Quality Assurance:
  1. Required:
    - a. Architect to engage an Independent Architectural Hardware Consultant (AHC), approved by the University Lock Shop, and registered as a USC eMarket Vendor, as listed in below "Exhibits", to provide consultation and prepare door hardware specification during Design Development, Construction Document and Construction Administration Phases, certified by Door Hardware Institute (DHI) and experienced in projects of similar scope, material and design.
    - b. No in-house specifier or out-sourced specifier shall be used by Architect/Design Professional to prepare door hardware specifications.
    - c. Independent Architectural Hardware Consultant shall be defined as not having any conflicts of interest, affiliation or employment by any manufacturer, factory representative or contract hardware distributor.
    - d. See below "Field Quality Control" section for consultant requirements during "Close Out Phase". Warranty Period for Mechanical Hardware: Three years from date of Substantial Completion.
    - e. Warranty Period for Electronic Hardware: Two years from date of Substantial Completion.

Door Schedule and Floor Plans: Door identification numbers shall conform to University Basis-of-Design as follows:

  - 1) All rooms with doors are to be identified by room number followed by a dot and number (i.e. 101.1).
  - 2) Where there are two or more doors in a room use numeric sequence.
  - 3) The numbers for stair wells and corridors/lobbies/vestibules shall use the established standard:
    - 1<sup>st</sup> Character: Alpha code identifying Stairs (S); Corridors (C)
    - 2<sup>nd</sup> Character: Floor code (i.e. B, P, R, 1, 2, 3, 4, etc.)
    - 3<sup>rd</sup> Character for Stairs: Use a number for the space identifier (i.e. S11 = Stairs, 1<sup>st</sup> Floor, Stair #1)
    - 3<sup>rd</sup> Character for Corridors: Use an alpha for space identifier (A, B, C, D, Etc.; i.e. C1A = Corridor, 1<sup>st</sup> Floor, #A

### 3. PRODUCT REQUIREMENTS

- A. Manufacturers and Products: To be determined on a per-project basis for each building type and function.
  1. Required: Complying with Builders Hardware Manufacturers Association (BHMA).

## USC DESIGN GUIDELINES

2. Required: Refer to the following existing USC Specifications:
  - a. University Park Campus (UPC) Specification Section 087101 "Door Hardware".
  - b. Health Science Campus (HSC) Specification Section 087102 "Door Hardware".
  - c. Student Housing Residential (HSM) Specification Section 087103 "Door Hardware" – PENDING.

### 4. EXECUTION REQUIREMENTS, GENERAL

- A. Installation: Specific requirements will be determined on a per-project basis. The following apply to all projects:
  1. Required:
    - a. Door Hardware Institute (DHI): DHI A1 15.1 G "Installation Guide for Doors and Hardware."
    - b. Permanent cylinder cores to be furnished and installed by University Lock Shop.
  2. Required: Refer to the following existing USC Specifications:
    - a. University Park Campus (UPC) Specification Section 087101 "Door Hardware".
    - b. Health Science Campus (HSC) Specification Section 087102 "Door Hardware".
    - c. Student Housing Residential (HSM) Specification Section 087103 "Door Hardware" – PENDING.
- B. Field Quality Control:
  1. Required: Architect to engage an Independent Architectural Hardware Consultant (AHC), approved by the University Lock Shop as listed in below "Exhibits", to inspect installed hardware and prepare a report of their findings under Close Out Phase.
- C. Demonstration and Training:
  1. Required: Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

### 5. EVALUATION AND COMMISSIONING

- A. Occupancy Adjustment:
  1. Required: Prior to occupancy General Contractor to coordinate with Hardware installer to examine and adjust door hardware, including operating forces, to ensure proper function.
- B. Annual Fire Door Inspections
  1. All fire rated doors and frame assemblies to be inspected upon installation.
  2. General Contractor to furnish USC with excel sheet of all fire rated doors and frames for future inspections

## USC DESIGN GUIDELINES

### 6. EXHIBITS

- A. University Approved Independent Door Hardware Consultants (In alphabetical order):
1. Architectural Hardware Services [eMarket Vendor #110364-0].  
Phone: (626) 852-8802 or (626) 367-4999  
Contact: John Elmore, AHC  
Email: [ahside@earthlink.net](mailto:ahside@earthlink.net)
  2. Breesway Doors & Hardware Consulting [eMarket Vendor #129499-0].  
Phone: (626) 732-6621  
Contact: Thomas D. Breese, AHC, CCPR, FDAI  
Email: [tom.breese@breeswaydhc.com](mailto:tom.breese@breeswaydhc.com)
  3. Door + Hardware Consultants, Inc. [eMarket Vendor #40081-0 (Previous), #127428-0 (Current)].  
Phone: (310) 890-5394  
Contact: Scott Sabatini, DAOC, CFDHI, FDAI, CSI, CCPR  
Email: [ssabatini@doorhardwareconsultants.com](mailto:ssabatini@doorhardwareconsultants.com).  
Website: [www.doorhardwareconsultants.com](http://www.doorhardwareconsultants.com).
  4. Finish Hardware Technology [eMarket Vendor #40266-0].  
Phone: (818) 387-6083  
Contact: Wassana Srisarint, AHC, CSI  
Email: [wassana.s@finishhardwaretech.com](mailto:wassana.s@finishhardwaretech.com)  
Alternate Contact: Jon Thomasson  
Email: [jon.t@finishhardwaretech.com](mailto:jon.t@finishhardwaretech.com).  
Website: [www.finishhardwaretech.com](http://www.finishhardwaretech.com).
- B. University Approved Door Hardware Distributor/Installer Qualifications: Employ a company who has in their employment person(s) that are currently certified by DHI (Door & Hardware Institute) as an Architectural Hardware Consultant (AHC), Door + Hardware Technician (DHT), Door + Hardware Consultant (DHC), Door + Hardware Specification Consultant (DHSC), Certified Fire & Egress Door Assembly Inspection (CFDAI) or Architectural Openings Consultant (AOC), and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
- C. University Approved Door Hardware Distributors/Installers (In alphabetical order):
1. Construction Hardware Co.  
216 Pacific Street  
Pomona, CA 91768  
Office (909) 594-9093  
Fax (909) 594-3343  
Contact: Frank Velasquez  
Email: [frankvz@constructionhardwareco.com](mailto:frankvz@constructionhardwareco.com)  
USC eMarket Vendor #Pending

## USC DESIGN GUIDELINES

2. Doortek Systems, Inc.  
1550 S. Sinclair Street  
Anaheim, CA 92806  
Office: (714) 669-2771 Ext. 203  
Cell: (562) 212-1106  
Contact: Glen Ekstrom  
Email: [glene@doorteksystems.com](mailto:glene@doorteksystems.com)  
Website: [www.doorteksystems.com](http://www.doorteksystems.com)  
USC eMarket Vendor #Pending
3. E.J. Enterprises / Unified Door & Hardware Group  
511 S. Harbor Blvd., Building W  
La Habra, CA 90631  
Office: (714) 985-2900  
Fax: (714) 985-2910  
Cell: (714) 981-8018  
Contact: Bobby Weist  
Email: [Bobby\\_weist@udhgroup.com](mailto:Bobby_weist@udhgroup.com)  
USC eMarket Vendor #26691-0
4. Estrada Hardware  
15853 Monte Street C107  
Sylmar, CA 91342  
Office: (213) 262-2113  
Contact: Michael Estrada, AHC  
Email: [general@estradahardware.com](mailto:general@estradahardware.com)  
USC eMarket Vendor #Pending
5. G+G Door Products, Inc.  
7600 Stage Road  
Buena Park, CA 90621  
Office: (714) 228-2008  
Fax: (714) 228-2013  
Cell: (714) 240-4113  
Contact: Bernie R. Gabel  
Email: [ggbernie@sbcglobal.net](mailto:ggbernie@sbcglobal.net)  
USC eMarket Vendor #68919-0
6. Glore & Associates  
12010 Camilla St.  
Whittier, CA 90601  
Office: (562) 463-9615  
Fax: (562) 463-0685  
Cell: (714) 713-4189  
Contact: Paul Pratt  
Email: [ppratt@gloreandassociates.com](mailto:ppratt@gloreandassociates.com)  
Contact: Bill Glore  
Email: [Billglore1@yahoo.com](mailto:Billglore1@yahoo.com)  
USC eMarket Vendor #54440-0

## USC DESIGN GUIDELINES

7. Montgomery Hardware  
8777 Lanyard Court  
Rancho Cucamonga, CA 91730  
Office: (877) 917-0113  
Fax: (877) 917-0114  
Contact: Frank Pace  
Email: [fp@montgomeryhardware.com](mailto:fp@montgomeryhardware.com)  
USC eMarket Vendor #27748-0
  
8. Seeley Brothers  
1400 Moonstone  
Brea, CA 92821  
Office: (714) 224-3949  
Fax: (714) 224-3957  
Contact: Dave Seltzer  
Email: [Daves@seeleybros.com](mailto:Daves@seeleybros.com)  
USC eMarket Vendor #Pending
  
9. 3-D Door Company  
3578 E. Enterprise Drive  
Anaheim, CA 92807-1627  
Office: (714) 625-0311  
Cell: (714) 981-8019  
Contact: Mark Picco, FDAI  
Email: [mark@3-ddoor.com](mailto:mark@3-ddoor.com)  
USC eMarket Vendor #Pending
  
10. Roy E. Whitehead, Inc.  
2245 Via Cerro  
Riverside, CA 92509  
Office: (951) 682-1490  
Fax: (951) 682-1565  
Contact: Daniel Gilley  
Email: [www.rewinc.net](http://www.rewinc.net)  
USC eMarket Vendor #Pending

**END OF DOCUMENT**

## SECTION 08 71 01

### DOOR HARDWARE – UPC Guide Specification for Capital Construction

*[Adjust to Suit Project and Confirm with University Lock Shop; Conform to Architect's format]*

#### PART 1 - GENERAL

##### 1.1 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of Division 01 and Section 28 05 00 Specification Sections, apply to this Section.
- B. CALgreen Submittals:
  - 1. Product Data for Section 5.504.4.1: For sealants, adhesives and caulks, provide documentation including printed statement of VOC content showing compliance with SCAQMD Rule 1168 VOC limits and CCR Title 17 for aerosols.
  - 2. Product Certificates for Section A5.405.1: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. For the purposes of this requirement, "regional" is interpreted to mean within 500 miles of the project location or within the State of California.

##### 1.2 SUMMARY

- A. This Section includes the following :
  - 1. Door hardware for the following:
    - a. Swinging doors.
    - b. Non-fire-rated sliding doors.
    - c. Non-fire-rated folding doors.
    - d. Pedestrian Gates.
    - e. Other doors to the extent indicated.
  - 2. Interior Curtainwall and Interior Storefront Door hardware.
  - 3. Exterior Fiberglass Composite Door Hardware.
  - 4. Electrified door hardware, including electric locking and release hardware, low voltage power supplies for electric hardware and wall or floor mounted electromagnetic hold-open devices
  - 5. Cylinders for doors specified in other Sections.
  - 6. Padlocks
- B. Related Sections include the following:
  - 1. Section 08 11 13 "Hollow Metal Doors and Frames" for astragals provided as part of fire-rated labeled assemblies.



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2. Section 08 17 00 "Integrated Door Opening Assemblies" for integral inset exit device hardware factory installed into Hollow Metal Doors.
  3. Section 08 14 16 "Flush Wood Doors" for integral intumescent seals provided as part of fire-rated labeled assemblies.
  4. Section 08 16 13 Section "Fiberglass Composite Exterior Entrances and Exterior Storefronts" for entrance door hardware, except cylinders.
  5. Section 08 41 13 Section "Aluminum-Framed Interior Entrances and Interior Storefronts" for entrance door hardware, except cylinders.
  6. Division 08 Section "Overhead Coiling Grilles" for door hardware provided as part of overhead grille assemblies.
  7. Division 08 Section "Sound Control Door Assemblies" for hinges and gasketing provided as part of sound-rated door assemblies.
  8. Section 08 42 29 Section "Automatic Entrances".
  9. Section 08 71 13 Section "Automatic Door Operators".
  10. Section 07 92 00 "Joint Sealants"
  11. Division 26 Sections for connections to electrical power system and for low-voltage wiring work.
  12. Division 28 Section "Access Control" for access control devices installed at door openings and provided as part of a security access system.
  13. Division 28 Section "Intrusion Detection" for detection devices installed at door openings and provided as part of an intrusion detection system.
  14. Division 28 Section "Fire Detection and Alarm" for connections to building fire alarm system.
  15. Section 28 05 00 Security General Requirements
- C. The General Contractor shall furnish and install door hardware devices, locks, hinges and other components of the system as shown and specified, including termination of wiring.
1. Electrified mortise locks.
  2. Electrified emergency exiting hardware.
  3. Electrical locking system accessories.
- D. The Contractor shall coordinate door hardware requirements with the University to achieve the specified operation of the Access Control System.
- E. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
1. Cylinders for locks specified in other Sections.
- F. Products furnished and installed by others.
1. Permanent cylinder cores to be furnished and installed by University Lock Shop.
  2. Centralized power supplies furnished and installed by Division 28.
  3. Card Readers furnished and installed by Division 28.
  4. Door Position Switches furnished and installed by Division 28.

### 1.3 REFERENCES

- A. Use date of standard in effect as of Bid date:

UPC Guide Specification 08 71 01  
University of Southern California  
REVISION 2023.1.01-30-2023

Door Hardware

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[Note: Footer to conform with Architect's format]

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1. (ADA) - Americans with Disabilities Act of 1990.
2. (ANSI A117.1) - American National Standards Institute, Accessible and Usable Buildings and Facilities.
3. (ANSI) American National Standards Institute/ (BHMA) – Builders Hardware Manufacturers Association :
  - a. ANSI/BHMA A156.1 Standard for Butts and Hinges.
  - b. ANSI/BHMA A156.2 Standard for Bored Locks & Latches.
  - c. ANSI/BHMA A156.3 Standard for Exit Devices.
  - d. ANSI/BHMA A156.4 Standard for Door Closers.
  - e. ANSI/BHMA A156.5 Standard for Auxiliary Locks and Associated Products.
  - f. ANSI/BHMA A156.6 Standard for Architectural Door Trim.
  - g. ANSI/BHMA A156.7 Standard for Template Hinge Dimensions.
  - h. ANSI/BHMA A156.8 Standard for Door Controls – Overhaed Stops and Holders.
  - i. ANSI/BHMA A156.13 Standard for Mortise Locks & Latches.
  - j. ANSI/BHMA A156.14 Standard for Sliding and Folding Door Hardware.
  - k. ANSI/BHMA A156.15 Standard for Release Devices: Closer Holders, Electromagnetic and Electromechanical.
  - l. ANSI/BHMA A156.16 Standard for Auxiliary Hardware.
  - m. ANSI/BHMA A156.17 Standard for Self-Closing Hinges and Pivots.
  - n. ANSI/BHMA A156.18 Standard for Materials & Finishes.
  - o. ANSI/BHMA A156.19 Standard for Power Assist & Low Energy Power Operated Doors.
  - p. ANSI/BHMA A156.21 Standard for Thresholds.
  - q. ANSI/BHMA A156.22 Standard for Door Gasketing Systems.
  - r. ANSI/BHMA A156.23 Standard for Electromagnetic Locks.
  - s. ANSI/BHMA A156.24 Standard for Delayed Egress Locks.
  - t. ANSI/BHMA A156.25 Standard for Electrified Locking Devices.
  - u. ANSI/BHMA A156.26 Standard for Continuous Hinges.
  - v. ANSI/BHMA A156.28 Standard for Recommended Practices for Mechanical Keying Systems.
  - w. ANSI/BHMA A156.29 Standard for Exit Locks, Exit Locks with Exit Alarms, Exit Alarms, Alarms for Exit.
  - x. ANSI/BHMA A156.30 Standard for High Security Cylinders.
  - y. ANSI/BHMA A156.31 Standard for Electrified Strikes and Frame Mounted Activators.
  - z. ANSI/BHMA A156.32 Standard for Integrated Door Opening Assemblies.
  - aa. ANSI/BHMA A156.36 Standard for Auxiliary Locks.
  - bb. ANSI/BHMA A156.41 Standard for Door Hardware Single Motion to Egress.
  - cc. ANSI/BHMA A156.115 Standard for Hardware Preparation in Steel Doors with Steel Frames.
  - dd. ANSI/BHMA A156.115W Standard for Hardware Preparation in Wood Doors with Wood or Steel Frames.
4. (DHI) - Door Hardware Institute.
  - a. DHI A115.1G Installation Guide for Doors and Hardware.
  - b. DHI Recommended Sequence and Format for the Hardware Schedule.
  - c. DHI Keying Systems and Nomenclature.
5. (DOJ) – Department of Justice.
  - a. ADA Standards for Accessible Design.
6. (NFPA) – National Fire Protection Association:
  - a. NFPA 80 Fire Doors and Other Opening Protectives.

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- b. NFPA 101 Life Safety Code
- c. NFPA 105 Smoke Door Assemblies and Other Opening Protectives
- d. NFPA 252 Fire Tests of Door Assemblies.
- 7. (SDI) – Steel Door Institute:
  - a. SDI 100 Recommended Specifications for Standard Steel Doors and Frames.
  - b. SDI 122 Installation of Standard Steel Doors and Frames.
  - c. (UL) – Underwriters Laboratories Inc.:
    - a. UL10C Positive Pressure Fire Tests of Door Assemblies.
    - b. UL294 Standard for Access Control System Units.
    - c. UL305 Panic Hardware.
    - d. UL437 Drill and Pick Resistant Key Cylinders.
    - e. UL1034 Burglary-Resistant Electric Locking Mechanisms.
    - f. Standards for Electrified Locking Equipment and Power Supplies.
    - g. UL1784 Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives.
- 8. (WDMA I. S. 1A) – Window and Door Manufacturers Association, Industry Standard for Architectural Wood Flush Doors.
- 9. (WHI) – Warnock Hersey Incorporated (Intertek or ITS)

B. Abbreviations

- 1. EACS – Electronic Access Control System
  - a. Refer to Section 28 05 00

#### 1.4 REGULATORY REQUIREMENTS

A. Conform to the following:

- 1. (CBC) - California Building Code.
- 2. (CFC) – California Fire Code.
- 3. (LABC) - City of Los Angeles Building Code.
- 4. (Title 24, CCR) - California Building Standards Reference Code.

#### 1.5 SHOP DRAWINGS AND SUBMITTALS

- A. In accordance with Section 01 33 00 Submittal Procedures and Section 28 05 00, Security General Requirements.
- B. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. Shop Drawings: Details of electrified door hardware, indicating the following:
  - 1. Wiring Diagrams: Power, signal, and control wiring. Furnished by Division 28.
  - 2. Description and Sequence of Operation of each electrified door hardware function.
    - a. Furnished by Division 28.
    - b. General Contractor to coordinate with Division 28.

Note: Header to conform with Architect's format

- D. Product Certificates: For electrified door hardware, signed by product manufacturer.
  - 1. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.
- E. Qualification Data: For Consultant per Part 1.7.B.
- F. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware schedule.
- G. Warranty: Provide manufacturer printed warranty data.
- H. Other Action Submittals:
  - 1. Door Hardware Schedule (Sets): Submit one electronic copy or six hard copies prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
    - a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
    - b. Format: Use same scheduling sequence and use same door numbers as in the Contract Documents.
    - c. Content: Include the following information:
      - 1) Identification number, location, hand, fire rating and material of each door and frame. Door identification numbers shall conform to University Basis-of-Design as follows:
        - a) All rooms with doors are to be identified by room number followed by a dot and number (i.e. 101.1).
        - b) Where there are two or more doors in a room use numeric sequence.
        - c) The numbers for stair wells and corridors/lobbies/vestibules shall use the established standard:
          - 1<sup>st</sup> Character: Alpha code identifying Stairs (S); Corridors (C)
          - 2<sup>nd</sup> Character: Floor code (i.e. B, P, R, 1, 2, 3, 4, etc.)
          - 3<sup>rd</sup> Character for Stairs: Use a number for the space identifier (i.e. S11 = Stairs, 1<sup>st</sup> Floor, Stair #1)
          - 3<sup>rd</sup> Character for Corridors: Use an alpha for space identifier (A, B, C, D, Etc.; i.e. C1A = Corridor, 1<sup>st</sup> Floor, #A
      - 2) Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device.
      - 3) Complete designations of every item required for each door or opening including name and manufacturer.
      - 4) Fastenings and other pertinent information.
      - 5) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
      - 6) Explanation of abbreviations, symbols, and codes contained in schedule.
      - 7) Mounting locations for door hardware.

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- 8) Degree of swing for each door.
  - 9) Door and frame sizes and materials.
  - 10) Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
    - a) Sequence of Operation: General Contractor to coordinate with Division 28.
  - 11) List of related door devices specified in other Sections for each door and frame.
    - d. Submittal Sequence: Submit the final door hardware schedule with sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.
2. Keying Matrix: General Contractor to furnish a keying matrix immediately following Keying Conference under 1.7.F to be conducted a minimum of three months prior to Temporary Certificate of Occupancy (TCO) in a format provided by University.

#### 1.6 DOOR REQUIREMENTS

- A. Door Position Switches shall be furnished and installed by the Security Contractor.
- B. Mechanical Request-To-Exit (REX) switches required at all exterior doors and all doors with electrified hardware, except for electro-magnetic door holders.
- C. Electrical Power Transfers (EPT) required at all exterior doors and doors with panic exit devices.
- D. All rooms must be capable of being lockable to method defined by University standards.
  1. All conference rooms to lock unless located within a lockable suite.
- E. Classroom Security Per University Door Hardware Matrix or Method prescribed by USC Lock Shop per specific project:
  1. New and existing hardwired Networked Card Reader/Electrified Hardware:
    - a. Furnish SDC 434KLDURL2 Lockdown button(s) on inside of classroom at each egress door and non-egress side(s) walls, as required.
      - 1) STI-6518 Flip Cover.
    - b. Remote Lockdown capabilities.
  2. New and existing WiFi enabled or standalone Schlage AD400 Access Control Locksets on Lenel:
    - a. Furnish SDC 434KLDURL2 Lockdown button(s) on inside of classroom at each egress door and non-egress side(s) walls, as required.
      - 1) STI-6518 Flip Cover.
    - b. Remote Lockdown capabilities.

Note: Header to conform with Architect's format

3. Existing standalone Schlage AD200/Omnilocks and Mechanical Classroom Function Locksets.
    - a. Furnish the following on inside of room:
      - 1) SDC 1500 Series Magnetic Lock
      - 2) SDC 602RF x RB12V4 Power Supply
      - 3) SDC 423MU Exit Button
      - 4) SDC 434KLDURL2 Lockdown button(s) on inside of classroom at each egress door and non-egress side(s) walls, as required.
        - a) STI-6518 Flip Cover.
      - 5) Field modify existing egress side mechanical operating hardware with mechanical Request-To-Exit (REX) switch
      - 6) Local Lockdown only; No remote Lockdown capabilities
    - b. Furnish the following on outside of room:
      - 1) SDC 700 Series Key Switch
      - 2) Campus Standard Mortise Cylinder for access only by DPS
  4. No substitutions allowed without prior approval of Lock Shop Supervisor
- F. Delayed Egress Systems:
1. When Delayed Egress Systems are required the following shall be used:
    - a. Delayed Egress Electromagnetic Lock: Security Door Controls (SDC) Integrated Exit Check 1511(S/T)-NC-KV-L-D-B-A-V1
    - b. Delayed Egress Controller: Security Door Controls (SDC) 101-AK
    - c. Power Supply: Security Door Controls (SDC) 630RF Series
      - 1) Mortise Cylinder: USC Lock Shop to verify required cylinder housing
      - 2) Permanent Cylinder Core: To be furnished by USC Lock Shop
  2. Delayed Egress System activated by Request-to-Exit (REX) switch in exit device or mortise lock. Von Duprin Chex-It Delayed Egress Exit Device not allowed.
  3. Shunt by card reader and door position switch furnished by Security Contractor.
- G. Interlocks
1. When Interlocks are required the following shall be used:
    - a. Inside of Room:
      - 1) Magnetic Lock(s): Security Door Controls (SDC) 1511-V-D-B-TJ1
      - 2) Power Supply: Security Door Controls (SDC) 632RF x UR4-8 x RB12V7
      - 3) LED Status Indicator(s): Security Door Controls (SDC) 400U-L2-Red/Grn
      - 4) Emergency Door Release: Safety Technology Intl (STI) STI-2048EM-EN
    - b. Outside of Room:
      - 1) Maintained Key Switch: Security Door Controls (SDC) 700UL1-Red
      - 2) Mortise Cylinder: USC Lock Shop to verify required cylinder housing
      - 3) Permanent Cylinder Core: To be furnished by USC Lock Shop
    - c. System Point-to-Point Wiring Diagram by Security Door Controls (SDC)
  2. No substitutions allowed without prior approval of Lock Shop Supervisor
- H. Roof Doors to/from Stair
1. All roof doors to conform with LAFD Fire Prevention & Public Safety Bureau Requirement #102.
  2. Existing Roof Door
    - a. Existing hollow metal door and frame to remain.
      - 1) Properly fill, repair and patch any unused holes or preparations.
      - 2) Field verify 90-Minute fire labels are intact and readily visible.

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- 3) Field verify glazing and tape in vision lite is intact with no breaks.
- 4) Field verify tolerances meet NFPA-80 for fire doors.
  - a) Perform necessary corrective actions.
- b. Following existing hardware to remain, unless corrective active required:
  - 1) Butt Hinges:
    - a) Field verify hinges have stainless steel base metal and have non-removable pins (NRP) or replace with Hager BB1191 4.5 x 4.5 x NRP x 630.
    - b) Field verify if thru-wired power transfer hinge is required or replace with Command Access Technologies ETH-2WH 4.5 x 4.5 x 630.
  - 2) Continuous Hinge:
    - a) Field install Security Door Controls Electrical Power Transfer PT-5.
  - 3) Exit Device:
    - a) Field verify UL Labeled as "Fire Exit Hardware"
    - b) Exit device bar on stair side replace lever trim with Command Access Technologies V96BE-REE-L6 or Von Duprin BE-RX996L-06.
    - c) Exit device bar on roof side add Command Access Technologies REX switch VDREXKIT-ED.
  - 4) Mortise Lock:
    - a) Remove existing mortise lock and replace with mortise passage latchset (Yale 8801FL @ HSC or Corbin-Russwin ML2010 @ UPC).
    - b) Factory install at Command Access Technologies Request-to-Exit REX switch on roof side lever.
  - 5) Cylindrical Lock:
    - a) Remove existing cylindrical lock and replace with cylindrical passage latchset Yale AU5401.
    - b) Factory install at Command Access Technologies Request-to-Exit REX switch on roof side lever.
  - 6) Surface Closer:
    - a) Field verify existing door closer is intact and in good condition or replace with LCN 4040XP-SCUSH.
  - 7) Perimeter Head and Jamb Seals; Door Bottom/Sweep:
    - a) Field verify existing seals and door bottom/sweep are intact and in good condition or replace with products listed under Part 2.30.
- c. Following new door hardware to be furnished and installed:
  - 1) Install Security Door Controls Magnetic Lock 1571 D-BAS-V on stair side
  - 2) Install Security Door Controls Emergency Door Release 492 x 492-BB on stair side wall adjacent to door
  - 3) Install Security Door Controls Power Supply 602RF 120VAC on stair side
  - 4) Install Security Door Controls Mushroom Exit Button 446U Series x 630 on roof side wall adjacent to door
    - a) Install mushroom exit button on roof side into wall mounted Safety Technology International Waterproof Cover STI-1350 x Custom Warning Label
- d. Access Control
  - 1) Card Reader/Intercom to be installed on stair side
    - a) Replace existing card reader with Lenel reader 2 N Intercom with Camera
  - 2) Fire alarm interface on Lenel Panel
    - a) Verify existing to remain or install new interface

- b) Network drop to roof stair terminal can
- c) Add new rated backboard and power supply
- d) Run network cable, outside push button conduit and provide pathway for fire alarm tie in
- e) Install jack in 6x6 terminal can near door with the sounder mounted to it
- f) Field verify existing door position switch is intact and operational
- e. Signage and Operational Intent
  - 1) Existing Roof side illuminated EXIT sign to remain
  - 2) Existing Stair side signage to be removed
  - 3) New Stair side signage and Operational Intent
    - a) Door locked when powered
    - b) Not an exit
    - c) Door will unlock upon emergency door release, fire alarm or loss of power
    - d) Proper credential will unlock momentarily and rearm
    - e) Two-Way communication and remote release
  - 4) New Roof side signage and Operational Intent
    - a) Door locked when powered
    - b) Depressing lever handle will activate switch which momentarily deactivates power to magnetic lock for egress into building
    - c) Emergency wall mounted mushroom button will also momentarily deactivate power to magnetic lock if lever handle switch is not successful
    - d) Door will unlock upon fire alarm or loss of power
- 3. New Roof Door
  - a. 90-Minute S fire labeled 16-gage continuously welded hollow metal frame.
  - b. 90-Minute S fire labeled 16-gage steel stiffened hollow metal door.
  - c. Door hardware:
    - 1) Butt Hinges:
      - a) Heavy Weight stainless steel base metal (Hager BB1199 4.5 x 4.5 x NRP x 630, or approved equal).
      - b) Heavy Weight stainless steel base metal thru-wired power transfer hinge (Hager BB1199ETW 4.5 x 4.5 x 630, or approved equal).
    - 2) Mortise Passage Latchset:
      - a) Yale 8801FL @ HSC or Corbin-Russwin ML2010 @ UPC.
      - b) Factory install at Command Access Technologies Request-to-Exit REX switch on roof side lever.
    - 3) Surface Closer: LCN 4040XP-SCUSH.
    - 4) Perimeter Head and Jamb Seals; Door Bottom/Sweep:
      - a) Products listed under Part 2.30.
    - 5) Threshold per Architectural sill detail as required for condition.
  - d. Electrical Hardware:
    - 1) Install Security Door Controls Magnetic Lock 1571 D-BAS-V on stair side
    - 2) Install Security Door Controls Emergency Door Release 492 x 492-BB on stair side wall adjacent to door
    - 3) Install Security Door Controls Power Supply 602RF 120VAC on stair side
    - 4) Install Security Door Controls Mushroom Exit Button 446U Series x 630 on roof side wall adjacent to door



Note: Header to conform with Architect's format

- a) Install mushroom exit button on roof side into wall mounted Safety Technology International Waterproof Cover STI-1350 x Custom Warning Label
- e. Access Control
  - 1) Card Reader/Intercom to be installed on stair side
    - a) Replace existing card reader with Lenel reader 2 N Intercom with Camera
  - 2) Fire alarm interface on Lenel Panel
    - a) Verify existing to remain or install new interface
    - b) Network drop to roof stair terminal can
    - c) Add new rated backboard and power supply
    - d) Run network cable, outside push button conduit and provide pathway for fire alarm tie in
    - e) Install jack in 6x6 terminal can near door with the sounder mounted to it
    - f) Field verify existing door position switch is intact and operational
- f. Signage and Operational Intent
  - 1) Roof side illuminated EXIT sign
  - 2) Stair side signage and Operational Intent
    - a) Door locked when powered
    - b) Not an exit
    - c) Door will unlock upon emergency door release, fire alarm or loss of power
    - d) Proper credential will unlock momentarily and rearm
    - e) Two-Way communication and remote release
  - 3) New Roof side signage and Operational Intent
    - a) Door locked when powered
    - b) Depressing lever handle will activate switch which momentarily deactivates power to magnetic lock for egress into building
    - c) Emergency wall mounted mushroom button will also momentarily deactivate power to magnetic lock if lever handle switch is not successful
    - d) Door will unlock upon fire alarm or loss of power

#### I. Pedestrian Gates

- a. Welded Gate Boxes:
  - 1) Exit Device – Keedex K-BXED-V992L-2, or approved equal.
  - 2) Corbin/Yale Mortise Lock – Keedex K-BXMOR2, or approved equal.
  - 3) Schlage AD/ Corbin-Russwin IN120 Mortise Lock – Keedex K-BXMOR8155, or approved equal.
- b. Exit Device Plates:
  - 1) Adjustable Mounting Plate - DAC Industries 6500-B-24"-Basic, or approved equal.
  - 2) Latch Protector – DAC Industries 6015, or approved equal.
  - 3) Push Pad Protector – DAC Industries 6017, or approved equal gate shield per drawings.
- c. Gate Pivots and Closer (Only where no frame head exists):
  - 1) D&D Technologies SureClose
  - 2) Locinox Mammoth-180/ Mammoth-HD
- d. Power Transfer (No flexible door loops allowed):

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- 1) Security Door Controls (Model PT-5) for maximum 105-degree swing.
- 2) Adams Rite (Model 4612-1 for up to 105-degree swing)
  - a) Adams Rite Model 4612-2 for 180-degree swing.

## 1.7 QUALITY ASSURANCE

- A. Supplier Qualifications: An employer of workers trained and only as listed in University Approved Door Hardware Distributors/Installers under Basis-of-Design (BOD).
1. Supplier's responsibilities include supplying and installing door hardware, and providing a qualified Consultant per Part 1.7.B available during the course of the Work to consult with Contractor, Architect, and University about door hardware and keying.
  2. Supplier shall have warehousing facilities in Project's vicinity.
  3. Scheduling Responsibility: Preparation of door hardware and keying schedules.
  4. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. University Approved Door Hardware Distributor/Installer Qualifications: Employ a company who has in their employment person(s) that are currently certified by DHI as an Architectural Hardware Consultant (AHC), Door + Hardware Technician (DHT), Door + Hardware Consultant (DHC), Door + Hardware Specification Consultant (DHSC), Certified Fire & Egress Door Assembly Inspection (CFDAI) or Architectural Openings Consultant (AOC), and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
1. Electrified Door Hardware Consultant Qualifications: A qualified Electrified Hardware Consultant (EHC), Access Control System Consultant (ACSC) or Architectural Openings Consultant (AOC) who is experienced in providing consulting services for electrified door hardware installations.
- C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C Positive Pressure.
1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches (1016 mm) or less above the sill.
- D. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- E. Pre-Installation Conferences:
1. Mechanical hardware: Arrange conference at job site to coordinate door, frame, hardware and electronic security hardware installation; to be attended by the Architect, Owner, Contractor and representative personnel of firms involved in the provision and installation of said items.
  2. Electrified hardware: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to electrified door hardware including, but not limited to, the following:

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- a. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.
  - b. Review sequence of operation for each type of electrified door hardware.
  - c. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - d. Review required testing, inspecting, and certifying procedures.
- F. Keying Conference: Conduct conference at Project site after receipt of approved submittals and a minimum of three months prior to Temporary Certificate of Occupancy (TCO) to comply with requirements in Division 01 Section "Project Management and Coordination." Conference participants shall include General Contractor, Architect, University Project Manager, University Lock Shop, and General Contractor's door hardware supplier. The University Project Manager will determine additional participants from appropriate department(s). Incorporate keying conference decisions into final keying matrix after reviewing door hardware keying system including, but not limited to, the following:
1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
  2. Requirements for key control system.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys and permanent cores directly from manufacturer to University (Facilities Lock Shop Supervisor) by registered mail or overnight package service, with signature required.

#### 1.9 COORDINATION

- A. Coordinate layout and installation of recessed pivots and concealed floor-closers with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

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- C. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices an access control system.

## 1.10 WARRANTY

Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
  - a. Structural failures including excessive deflection, cracking, or breakage.
  - b. Faulty operation of operators and door hardware.
  - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
2. Warranty Period: Two years from date of Substantial Completion, except as follows:
  - a. Continuous Hinges: Five years from date of Substantial Completion.
  - b. Cylindrical Lever Locksets: Five years from date of Substantial Completion.
  - c. Mortise Lever Locksets: Five years from date of Substantial Completion.
  - d. Exit Devices: Three years from date of Substantial Completion.
  - e. Manual Closers: Ten years from date of Substantial Completion.
  - f. Electrified Hardware: Two years from date of Substantial Completion.

## 1.11 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for University's continued adjustment, maintenance, and removal and replacement of door hardware.

## PART 2 - PRODUCTS

### 2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this Section and door hardware sets indicated in Part 3 "Door Hardware Sets" Article.
  1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated.
  2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Sets" Article. Products are identified by descriptive titles corresponding to requirements specified in Part 2.

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- C. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
  - 2. Alternate Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include manufacturers specified.
- D. Product Substitutions: Provide products as specified. The University shall be the sole judge of whether or not a submitted substitution is deemed to be "equivalent" and accepted.
- E. Fire Rated Doors: Coordinate security hardware equipment and installation so as to maintain the Fire Rating of each specific door to the satisfaction of the local Authority Having Jurisdiction.

## 2.2 HINGES, GENERAL

- A. Quantity: Provide the following, unless otherwise indicated:
  - 1. Two Hinges: For doors with heights up to 60 inches (1524 mm).
  - 2. Three Hinges: For doors with heights 61 to 90 inches (1549 to 2286 mm).
  - 3. Four Hinges: For doors with heights 91 to 120 inches (2311 to 3048 mm).
  - 4. For doors with heights more than 120 inches (3048 mm), provide 4 hinges, plus 1 hinge for every 30 inches (750 mm) of door height greater than 120 inches (3048 mm).
- B. Insert sizes, including hinge height and metal thickness, only if they are not included in door hardware sets.
- C. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
- D. Hinge Size: Provide the following, unless otherwise indicated:
  - 1. Doors up to three foot wide: Standard weight 4 ½ x 4 ½ inches.
  - 2. Doors three foot six inch wide: Heavy-weight 4 ½ x 4 ½ inches.
  - 3. Doors greater than three foot six inch wide: Heavy-weight 5 x 4 ½ inches.
- E. Hinge Type and Weight: Unless otherwise indicated, provide the following:
  - 1. Entrance Doors, Exterior Doors, Doors with Panic Exit Devices, High-Use, High-Abuse and doors with Automatic Operators: Heavy-duty Continuous Hinges unless specified otherwise.
  - 2. Interior Doors: Standard-weight hinges or heavy-weight hinges as required by door size.
  - 3. Doors with Closers: Antifriction concealed bearing hinges.
  - 4. Furnish heavy-weight concealed ball bearing hinges where specified.
  - 5. Incombustible Mineral Core Doors: Continuous hinges or heavy-weight concealed ball bearing hinges.

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- F. Hinge Base Metal: Unless otherwise indicated, provide the following:
  - 1. Exterior Hinges: Stainless steel, with stainless-steel pin.
  - 2. Interior Hinges: Steel, or stainless steel, as scheduled.
  - 3. Hinges for Fire-Rated Assemblies: Steel, with steel pin.
- G. Anti-friction Concealed-Bearing, Full-Mortise (Butt) Hinges: BHMA A156.1, heavy weight; Grade 1, with concealed ball bearings, standard weight with concealed ball bearings; button tips; non-rising removable pins.
- H. Hinge Options: Where indicated in door hardware sets or on Drawings:
  - 1. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for reverse-bevel exterior doors.
  - 2. Corners: Square.
- I. Fasteners: Comply with the following:
  - 1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
  - 2. Wood Screws: For wood doors and frames.
  - 3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
  - 4. Screws: Phillips flat-head; machine screws drilled and tapped holes for metal doors wood screws for wood doors and frames. Finish screw heads to match surface of hinges.

## 2.3 HINGES

- A. Butts and Hinges: Certified Grade 1 BHMA A156.1 and listed under Category A in BHMA's "Certified Product Directory."
- B. Template Hinge Dimensions: BHMA A156.7.
- C. Manufacturers:
  - 1. Specified: Hager Companies 3 Knuckle
  - 2. Alternate: Bommer, McKinney, PBB, Stanley.

## 2.4 NOT USED

## 2.5 CONTINUOUS HINGES

- A. Standard: Certified BHMA A156.26 Grade 1-300.
  - 1. Continuous Hinges: Listed under Category N in BHMA's "Certified Product Directory."
- B. Continuous Gear-Type Hinges: Extruded 6063-T6 aluminum alloy, pin-less. Continuous hinges for fire rated doors shall be UL10C listed for type of assembly, without restrictions for wall type and not requiring fire pins up to and including 90 minute rating.

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1. Manufacturers:

- a. Specified: National Guard Products.
- b. Alternate: Hager/Roton, Ives, Pemko, Select, Zero.

D. Continuous Pin and Barrel-Type Hinges: Stainless steel hinge leafs with knuckles formed around a stainless steel pin that extends entire length of hinge. Furnish with Hospital Tips (HT) Medical Bearings (MB option). Continuous hinges for fire rated doors shall be UL10C listed for type of assembly, without restrictions for wall type and not requiring fire pins up to an including 3-Hour rating. Continuous metal shims shall be furnished by hinge manufacturer.

1. Manufacturers:

- a. Specified: National Guard Products.
- b. Alternate: Hager, Markar, PBB, Pemko, Select.

2.6 ELECTRIFIED HINGES AND POWER TRANSFERS

A. Electrified Hinges: Schedule at interior low-frequency doors which require electrified door hardware. Comply with the following:

- 1. Power Transfer: Concealed flexible connector high-temperature Teflon 19-strand wires, secured at each leaf, with centered access holes.
- 2. Wire leads: Furnish with 4 foot leads, or length of the wire chase plus one foot, whichever is greater.
- 3. Manufacturers:
  - a. Specified: Hager Companies
  - b. Alternate: Bommer, Command Access, Ives, McKinney, PBB, Stanley

B. Electrified Continuous Hinges: Schedule at exterior doors, doors with panic exit hardware and automatic power operated doors equipped with continuous hinges. Comply with the following:

- 1. Power Transfer: Provide cutout to accommodate Command Access Power Transfer.
  - a. Part #72425: CATEPT4WH\_ALUM\_CON X 48" Leads & 12" CON Pigtails on both sides (Command Access EPT)
  - b. Part #72426: CATEPT4WH\_DURO\_CON X 24" Leads & 12" CON Pigtails on both sides (Command Access EPT)
  - c. Part #72427: CATEPT10WH\_ALUM\_CON X 24" Leads & 12" CON Pigtails on both sides (Command Access EPT)
  - d. Part #72428: CATEPT10WH\_DURO\_CON X 24" Leads & 12" CON Pigtails on both sides (Command Access EPT)
  - e. Part #72429M: CATEPT4WH\_CON X 24" Leads & 12" CON Pigtails on both sides (Modification of customer's VD EPT)
  - f. Part #72430M: CATEPT10WH\_CON X 24" Leads & 12" CON Pigtails on both sides (Modification of customer's VD EPT)
- 2. Manufacturers:
  - a. Specified: National Guard Products.
  - b. Alternate: Hager, Ives, Markar, PBB, Pemko, Select, Zero.

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- C. Power Transfers: Schedule at exit doors, high-traffic doors, and all doors with electrified exit devices. Comply with the following:
  - 1. Electrical power transfer in all-metal housing, as scheduled, completely concealed when door is closed, suited for abusive installations, UL10C listed model, designed to accommodate degree of swing.
    - a. Transfer shall be tested to minimum 1,000,000 cycles.
    - b. Wire leads: In-rush current rating minimum designed to meet required maximum amperage surge. Provide transfer with two 18 AWG wires and eight 22 AWG wires.
  - 2. All continuous hinges shall have electrical power transfers preparation performed by the manufacturer. Field modifying continuous hinges for electrical power transfers shall not be allowed.
  - 3. Manufacturers:
    - a. Specified: Command Access Power Transfer.
    - b. Alternate: None.
    - c. For narrow jamb or stile applications only, or where above power transfers not applicable:
      - a) Specified: Security Door Controls (Model PT-5) for maximum 105-degree swing.
      - b) Alternate: Adams Rite (Model 4612-1 for up to 105-degree swing)
      - c) Use Adams Rite Model 4612-1C for maximum 90-degree swing-clear
      - d) Use Adams Rite Model 4612-2 for 180-degree swing.

## 2.7 ELECTRIC STRIKES

- A. Electric strikes shall meet ANSI/BHMA A156.31 Grade 1 requirements, and be listed and labeled under UL 1034 Burglary Resistant Electric Locking Equipment.
- B. Electric strikes for fire rated openings shall be listed and labeled for such use by a testing agency acceptable to authorities having jurisdiction. Fail Secure (fail locked) strikes shall be used at all fire rated openings.
- C. Only acceptable at interior restrooms with automatic operators not connected to Lenel.
  - 1. Manufacturers:
    - a. Specified: HES 8300/8500 Series.
    - b. Alternate: None.

## 2.8 LOCKS AND LATCHES, GENERAL

- A. Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" ANSI A117.1.
  - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).



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- B. Latches and Locks for Means of Egress Doors: Comply with CBC 1010.1.9, 11A, 11B. Latches shall not require more than 15 lbf (67 N) to release the latch. Locks shall be readily operable from the inside and not require use of a key, tool, or special knowledge for free egress operation.
- C. Electrified Locking Devices: Comply with BHMA A156.25 and CBC 1010.1.9.7, 1010.1.9.8, 1010.1.9.9, 1010.1.9.12 for products as scheduled.
- D. Lock Trim:
  - 1. Levers: Accessible design as scheduled, through-bolted, cast or solid bar wrought lever trim.
    - a. Corbin-Russwin "LWA" is University Standard for UPC Campus.
  - 2. Roses: Wrought, with concealed fasteners.
  - 3. Dummy Trim: Match lever lock trim and escutcheons.
  - 4. Occupancy Indicators: Furnish mortise lock with M19VN Indicator which indicates "occupied" / "vacant" at privacy units scheduled for single occupant toilet rooms.
- E. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
  - 1. Mortise Locks: Stainless steel anti-friction, minimum 3/4-inch (19-mm) latch-bolt throw.
  - 2. Deadbolts: One-piece Stainless steel, minimum 1-inch (25-mm) bolt throw.
    - a. Only used when furnished as integral with mortise lock with simultaneous retraction.
- F. Backset: 2-3/4 inches (70 mm), unless otherwise indicated.
- G. Strikes: Manufacturer's standard strike with wrought steel strike box for each latch bolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:
  - 1. Strikes for Mortise Locks and Latches pairs doors: ANSI straight 7/8 inch lip to center.
  - 2. Strikes for Mortise Locks and Latches single doors: ANSI curved lip for mortise locks and latches, with lip length as required for proper clearance with frame trim. Straight lip strikes are not acceptable for single doors.
  - 3. Strikes for Auxiliary Deadlocks: BHMA A156.5.
  - 4. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
- H. Finishes
  - 1. Default finishes shall be BHMA 626 (Satin Chrome) on Yale 5400LN cylindrical locksets or BHMA 630 (Satin Stainless Steel) on Corbin-Russwin ML2000 mortise locksets.
  - 2. Alternate: Corbin-Russwin 613E where required to have dark bronze finish to match building standards.

## 2.9 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:

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1. Cylindrical Locks: BHMA A156.
  2. Mortise Locks: BHMA A156.13.
- B. Cylindrical Lever Locks: BHMA A156.2, Certified Grade 1; Series 4000. Yale RAU5400LN, heavy-duty Cylindrical Locks with free-wheeling lever when locked and prepared to accept interchangeable core master keyed to University System. Verify model number of interchangeable core prep to be used at each project with University Lock Shop. Use M-AU5400LN when Medeco cores are used. Note: Bored locksets should be used generally **for Campus remodel construction or existing retrofit only** and are not intended for new construction or for corridor applications. Verify with University Lock Shop prior to scheduling.
1. Manufacturers:
    - a. Specified: Yale Commercial Locks and Hardware; an ASSA ABLOY Group company.
    - b. Alternate: Schlage, an Allegion company, for electrified only.
  2. Cylindrical Lock Typical Functions:
    - a. Passage: 5401LN
    - b. Office: 5407LN
    - c. Classroom: 5408LN
    - d. Storeroom: 5405LN
    - e. Restroom: 5402LN
  3. Electrified Cylindrical Lock:
    - a. Schlage ND96EU-RX Rhodes 626, Corbin-Russwin 6pin-LFIC
- C. Mortise Lever Locks: Campus Standard locks, stamped chrome plated steel case with heavy gauge steel or brass parts; BHMA Grade 1 Heavy-duty, Corbin-Russwin Series ML2000, with quick reversible latch bolt, which allows unit to be re-handed, without disassembling case.
1. Manufacturers:
    - a. Specified: Corbin-Russwin; ASSA ABLOY Group Co (COR).
    - b. Alternate: None.
  2. Certifications:
    - a. BHMA A156.13, Certified Grade 1 Operational and Security.
    - b. UL10C Positive Pressure Fire Listed for up to and including three hour label.
  3. Mortise Lock Typical Functions:
    - a. Passage Latchset: ML2010
    - b. Suite Entry: ML2067 x M34
    - c. Offices: ML2054 x M34
    - d. Classroom: ML2055
    - e. Storeroom: ML2057
    - f. Restroom:
      - 1) Single Occupant: ML2065 V21 EMB
        - a) Lactation: ML2049 V21 EMB
      - 2) Multi-Occupant: ML2055
        - a) Alternate Hands Free Paddle Latchset: ML2055 HPSK Engraved
    - g. Student housing room entry: ML2067 M34

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## 2.10 AUXILIARY LOCKS AND LATCHES

- A. Auxiliary Locks: BHMA A156.5, Grade 1 unless Grade 2 is indicated. Listed under Category E in BHMA's "Certified Product Directory."
  - 1. Narrow Stile Auxiliary Locks: Not allowed unless approved by Lock Shop Supervisor.
  - 2. Sliding Door Auxiliary Locks:
    - a. Material: Stainless Steel/Brass/Bronze.
    - b. Deadlocks for Sliding Doors: Expanding- or interlocking-type deadbolt operated by key outside and ADA lever thumb-turn inside.
      - 1) Specified: Trimco 1074-2USC-T01-M1074053034.630 Munich x special cam (TRI)
      - 2) Alternate: Inox PD9550 XGT202 Munich x less cylinder (INO).
      - 3) Barn doors require Inox WS-90 or Trimco WS-1074 Series Wall Strike.

## 2.11 ACCESS CONTROL LOCKS AND TRIM

- A. Access Control Locks: Verify Manufacturer of Access Control Locks with University Lock Shop prior to specifying. ANSI BHMA A156.25, Certified Grade 1 for cylindrical and mortise locks, intended for retrofit construction. Access control locks specified under this Division to be purchased under Division 28.
  - 1. Manufacturers:
    - a. Specified: Schlage/Allegion.
    - b. Alternate: Corbin-Russwin/ASSA ABLOY IN120.
  - 2. Models used:
    - a. Interior New Construction or Retrofit, in buildings without Lenel: AD400 Series. Use of AD400 must be approved by Lockshop.
      - 1) Mortise Lock: Schlage/Allegion AD400-MS-70-MTK-TLR-JDCO6-4B
        - a) Corbin-Russwin/ASSA ABLOY: IN120-ML20234-BIPS-BIKPS-LWA-CT6D-M17-M34-SA114
      - 2) Cylindrical Lock: Schlage/Allegion AD400-CY-70-MTK-TLR-JDCO6-4B
        - a) Corbin-Russwin/ASSA ABLOY: IN120-CL33134-BIPS-BIKPS-NZD-CT6D-M17-SC114
      - 3) Exit Device Trim: Schlage/Allegion AD400-993R-70-MTK-TLR-JDCO0-4B x 050281 REX kit.
        - a) Corbin-Russwin/ASSA ABLOY Exit Device Trim: IN120-CREK1-231-L-BIPS-BIKPS
        - b) Single Wood Doors: Supported
        - c) Pairs of Wood Doors: Not Supported
        - d) Hollow Metal Single and Pairs: Supported
    - b. Interior New Construction or Interior Retrofit, offline: AD200 Series – Not Allowed.
    - c. All types of Schlage/Allegion models to receive four battery (4B) option.
      - 1) Corbin-Russwin IN locksets use 6 AA Non Proprietary batteries.

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- B. Access control lever trim shall match standard mechanical lockset and exit device lever trim.
- C. Units will accept current facility Proximity or Magnetic Stripe card formats. Verify card format with University Lock Shop. Corbin-Russwin/ASSA ABLOY will not support Magnetic Stripe card formats.
  - 1. Lockset Configuration: Lever lock or trim, prepared to accept facility Corbin Russwin interchangeable core.
  - 2. Provide key override capability by means of Corbin-Russwin Interchangeable Core cylinder. Keying shall be performed by University Lockshop.
  - 3. Panel Interface Modules (PIM)
    - a. When online AD400 series locks or trim are required furnish Panel Interface Module (PIM400-1501), furnished and installed under Division 28.
    - b. The AD-400 will connect to Lenel via PIM400-1501 without the need to connect to a panel. The AD400-1501 connects directly to network, and has its own panel integration into unit.
    - c. No panels or PIMS required with Corbin-Russwin/ASSA ABLOY IN120/IN220 Series Locksets.

## 2.12 ELECTRIFIED LOCKS AND LATCHES

- A. Mortise Locks: Campus Standard locks, stamped chrome plated steel case with heavy gauge steel or brass parts; BHMA Grade 1 Heavy-duty, Command Access ML05 series, with quick reversible latch bolt, which allows unit to be re-handed, without disassembling case. Lock shall be fail secure (EU) mode, with request-to-exit (REX) monitor, except at interior stair exit doors which shall have fail-safe (EL) operation. Do not schedule fail-safe electrified trim at exterior perimeter doors. Lever trim design shall be LWA.
  - 1. Manufacturers:
    - a. Specified: Command Access (CAT) ML05-EU/EL-REX-LWA.
    - b. Alternate: Corbin-Russwin (COR) ML20906 ECL Series-SEC/SAF-M92-LWA.
  - 2. Certifications:
    - a. BHMA A156.13, Certified Grade 1 Operational.
    - b. UL10C Positive Pressure Fire Listed for up to and including three hour label.
  - 3. Provide 24 VDC version.
- B. Electric Latch Controlled Mortise Locks: Motor operated, low voltage current draw, to retract latch for smooth, quiet retraction, self-contained in exit device rail, UL Listed; with 24 volt DC operation. Command Access LPM1 Series. Include patented PM300 interface power module, designed to allow centralized power supplies, with extended wire runs up to 700 feet, using 18/2

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wire. Centralized power supplies furnished and installed by Division 28. Furnish with integral Request to Exit (REX) switch. Comply with the following:

1. Manufacturers:
  - a. Specified: Command Access Technology (CAT).
  - b. Alternate: Security Door Controls Z7700 Series (SDC).

## 2.13 DOOR BOLTS, GENERAL

- A. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
  1. Fire-Rated Surface Bolts: Minimum 1-inch (25-mm) throw; listed and labeled for fire-rated doors.
  2. Mortise Flush Bolts: Minimum 3/4-inch (19-mm) throw.
- B. Dustproof Strikes: BHMA A156.16, Grade 1.
  1. Floor Type: Polished wrought brass, with 3/4-inch- (19-mm-) diameter, spring-tension plunger.
- C. Manual Flush Bolts: BHMA A156.16, Grade 1; designed for mortising into door edge. Fabricate from extruded brass or bronze, with 12-inch (305-mm) rod actuated by flat lever. Provide matching strike and equip with top rod extension.
- D. Slide Flush Bolts: Cast brass, with rod actuated by slide. Provide matching strike.

## 2.14 AUTOMATIC DOOR BOLTS

- A. Automatic Flush Bolts: Fabricated from steel and brass components, with spring-activated bolts that automatically retract when active leaf is opened and that automatically engage when active door depresses bolt trigger; listed and labeled for fire-rated doors. Provide brass or stainless-steel cover plate, top and bottom strikes, guides, guide supports, wear plates, and shims. Furnish two-piece, low-closing force designed units at inactive wood doors to maintain core material integrity and reduce potential delimitation. Top and Bottom bolts required; no less bottom bolt or bottom fire pins will be accepted.
  1. Furnish two-piece, low-closing force designed units at inactive wood doors to maintain core material integrity and reduce potential delimitation.
- B. Self-Latching Flush Bolts: Fabricated from steel and brass components, with spring-activated bolts that automatically engage when active door depresses trigger; listed and labeled for fire-rated doors. Bolts are manually retracted by a slide in the bolt face. Provide brass or stainless-steel cover plate, top and bottom strikes, guides, guide supports, wear plates, and shims. Top and Bottom bolts required; no less bottom bolt or bottom fire pins will be accepted.
- C. Dustproof Strikes:
  1. Floor Type: Polished wrought brass, with 3/4-inch- (19-mm-) diameter, spring-tension plunger.

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- D. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1; designed for mortising into door edge.
  - 1. Manufacturers:
    - a. Specified: Door Controls International.
      - 1) Wood Doors: Model 962.
      - 2) Metal Doors: Models 842/845.
    - b. Alternate: Rockwood; an ASSA ABLOY Company; Ives, an Allegion company; Trimco/Triangle Brass Manufacturing Company.

## 2.15 EXIT DEVICES, GENERAL

- A. Exit Devices: BHMA A156.3, Grade 1. Listed under Category G in BHMA's "Certified Product Directory", independent lab tested 1,000,000 cycles, with push-through touch pad design.
  - 1. Full compliance to UL 305 Standard for Safety: Panic Hardware.
    - a. Section 4.3: The ends of the crossbar or push pad shall be curved, guarded, or otherwise designed to prevent catching of clothing of persons during exit (Von Duprin PA).
- B. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities ADAAG" and ANSI A117.1. Comply with California Building Code Title 24.
  - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).
- C. Exit Devices for Means of Egress Doors: Comply with CBC 1010.1.10. Exit devices shall not require more than 15 lbf (67 N) to release the latch. Exit devices shall not require the use of a key, tool, or special knowledge for egress operation.
  - 1. All electrical rooms to receive panic exit devices regardless of rating, amperage or room size.
- D. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
  - 1. Furnish non-fire rated devices without dogging feature.
  - 2. Furnish Cylinder Dogging where required.
- E. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.
- F. Removable Mullions: Provide at specified locations as directed by University, removable mullions for use with exit devices complying with UL (and NFPA80 where labeled) tested and

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listed by inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions shall be used only with exit devices for which they have been tested. Removable with single turn of building key and securely installed with stabilizer brackets.

G. Outside Trim: Lever with cylinder, Pull with cylinder; material, finish and design to complement lever trim of locksets, unless otherwise indicated.

1. Lever Trim: Break-away type model 996L x 03, unless otherwise indicated.

H. Through-Bolts: For exit devices and trim on fire-rated wood doors.

I. Manufacturers:

1. Manufacturers:

a. Specified: Von Duprin; an Allegion Company.

1) PA98 Series at wide stiles.

b. Alternate: None.

G. Finishes

1. Default finishes shall be BHMA 626 (Satin Dull Chrome) or BHMA 630 (Satin Stainless Steel).

2. Alternate: Von Duprin 643e where required to have dark bronze finish to match building standards.

## 2.16 EXIT DEVICES

A. Rim Exit Devices:

1. Type: BHMA A156.3, Type 1, rim; Type 4, narrow stile.

2. Actuating Bar: Push pad.

3. Material: Aluminum/Brass/Bronze, as scheduled.

4. No traditional crossbar Von Duprin 55/88 Series, or other similar devices will be allowed unless prior approval of University Lock Shop Supervisor.

B. Concealed Vertical-Rod Exit Devices:

1. Type: BHMA A156.3, Type 6, narrow stile, Type 8, for metal doors.

2. Type: BHMA A156.3, Type 7, for wood doors.

3. Actuating Bar: Push pad.

4. Material: Aluminum/Brass/Bronze, as scheduled.

5. Configuration: Top and bottom rod. Use less bottom rod (LBR) option on interior doors. No cable devices will be allowed.

6. Furnish all concealed vertical rod (CVR) devices with two top and bottom latch mounting brackets (Model #109324 + screws).

7. All fire-rated and non-rated concealed vertical rod (CVR) devices with bottom rods to receive Von Duprin 385A floor strikes installed into floor or threshold.

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8. No Surface Vertical Rod devices will be allowed unless with prior approval of University Lock Shop Supervisor.
9. No traditional crossbar Von Duprin 55/88 Series, or other similar devices will be allowed unless with prior approval of University Lock Shop Supervisor.
10. Rigid, Housed, Perimeter Gasketing not to be cut for installation of rim exit device strikes, closer frame brackets or any other surface applied hardware.

C. Electric Latch Controlled Exit Devices: Motor operated, low voltage current draw, to retract latch for smooth, quiet retraction, self-contained in exit device rail, UL Listed; with 24 volt DC operation. Command Access MLRK1-VD. Include patented PM300 interface power module, designed to allow centralized power supplies, with extended wire runs up to 700 feet, using 18/2 wire. Centralized power supplies furnished and installed by Division 28. Furnish with integral Request to Exit (REX) switch. Comply with the following:

1. Manufacturers:
  - a. Specified: Command Access Technology CAT).
  - b. Alternate: None.

D. Electric Controlled Exit Device Trim: Solenoid 24VDC operated with full wave rectification, self-contained in inside lever escutcheon. Furnish fail-safe design at interior Stair exit doors. Furnish Electrified Lever Trim with Request to Exit (REX-Option) switch integral with exit device and key cylinder. Comply with the following:

1. Manufacturers:
  - a. Specified: Von Duprin M996 x REX.
  - b. Alternate: Command Access Technologies ET25-R/V-REX x CRU3.

E. Electric Strikes with Automatic Operators are allowed on interior doors only without Lenel.

1. Manufacturers:
  - a. Specified: HES
  - b. Alternate: Approved equal

## 2.17 LOCK CYLINDERS

A. Interchangeable Core Lock Cylinder Housings: BHMA A156.5, Grade 1.

1. Manufacturers:
  - a. Specified: Corbin-Russwin; ASSA ABLOY Group Co.
  - b. Alternate: None.

B. Cylinders: Interchangeable core, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:

1. Accepts Six-Pin Large Format Interchangeable Core (CT6).
2. Mortise Type: Threaded cylinders with rings and appropriate type cam to properly operate locking device.
3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
4. Security Collars: Equip Cylinders on exterior doors with Security Collar to prevent wrenching and rotating of cylinder.
  - a. Manufacturers:
    - 1) Specified: Corbin-Russwin 416F39.



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2) Alternate: None.

- C. Other Cylinder Housing and Core Requirements:
  - 1. Medeco buildings to receive Medeco Large Format Interchangeable Core on interior.
  - 2. All electrical rooms, mechanical spaces and ITS rooms to receive Medeco Large Format Interchangeable Electronic eKey cylinders.
  - 3. ASSA buildings to receive ASSA Large Format Interchangeable Cores.
  - 4. All Lenel controlled doors to receive ASSA Large Format Interchangeable Cores.
    - a. Corbin-Russwin Large Format Interchangeable Core at HSC only.
- D. Permanent Cores: Furnished and installed by University Lock Shop.
- E. Construction Keying and Cores: Comply with the following:
  - 1. Construction Master Keys: Provide 20 construction master keys.
  - 2. Construction Cores: Provide construction cores that are replaceable by permanent cores (CT6).
  - 3. Material: Brass. Plastic temporary or disposal cores will not be acceptable.
  - 4. University Lock Shop will return construction cores to General Contractor upon installation of permanent cores.
- F. Cylinder position on door or device must allow for key insertion and sufficient rotation to unlock from a minimum 4-inch diameter closed ring without interference or restrictions (University Department of Public Service, Lock Shop, FMS, etc.)
- G. Subject to compliance with LAFD Requirement 75, provide emergency entrance key vault(s); Knox Company 4400 Series, or 3200 Series. No Substitution Allowed.
  - 1. Finish Color - Black, Dark Bronze or Aluminum as selected by Architect.
  - 2. Where indicated provide security key override switches for electrically activated openings.
  - 3. Coordinate and provide keying and type per fire/ police department, and other jurisdictional agency requirements.
  - 4. Recessed mounting unless approved by Lock Shop Supervisor.

## 2.18 KEYING

- A. All keying and keys supplied by University Lock Shop.

## 2.19 OPERATING TRIM, GENERAL

- A. Standard: BHMA A156.6 and as illustrated on Drawings.
- B. Materials: Fabricate from stainless steel, bronze, or brass as scheduled.
- C. Manufacturers:
  - 1. Trimco.
  - 2. Ives, an Allegion company.
  - 3. Rockwood; an ASSA ABLOY company.

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## 2.20 OPERATING TRIM

- A. Push-Pull Plates: 1/8 inch (3.2 mm) thick, 4 inches wide by 16 inches high (102 mm wide by 406 mm high); with square corners, beveled edges, and raised integral lip; secured with exposed screws.
- B. Straight Door Pulls: 1-1/4-inch (19-mm) constant-diameter full height vertical pull on pull side of door only, with minimum clearance of 1-1/2 inches (38 mm) from face of door. Pull on push side of door must not obstruct bottom 10-inches of door.
  - 1. Mounting: Surface applied with concealed fasteners or Back to back with threaded sleeves.
  - 2. Straight door pulls mounting coordinating when locking cylinders as used for position on door must allow for key insertion and sufficient rotation to unlock from a minimum 4-inch diameter closed ring without interference or restrictions (University Department of Public Service, Lock Shop, FMS, etc.)
- C. Offset Door Pulls: 3/4-inch (19-mm) constant-diameter pull, with minimum clearance of 1-1/2 inches (38 mm) from face of door and offset of 2 inches (51 mm); fastened at minimum of 10 inches (203 mm) o.c.
  - 1. Hands Free design as approved by Lockshop.
  - 2. Mounting: Surface applied with concealed fasteners.
  - 3. Offset door pulls mounting coordinating when locking cylinders as used for position on door must allow for key insertion and sufficient rotation to unlock from a minimum 4-inch diameter closed ring without interference or restrictions (University Department of Public Service, Lock Shop, FMS, etc.)
- D. Pull-Plate Door Pulls: 1/8 inch thick plate, 4 inches wide by 16 inches high (102 mm wide by 406 mm high), with square corners and beveled edges; 3/4-inch (19-mm) constant-diameter pull, with minimum clearance of 1-1/2 inches (38 mm) from face of door; fastened at 8 inches (203 mm) o.c.
  - 1. Mounting: Surface applied with concealed fasteners.
- E. Custom Designer Pulls: Special or logo Push or Pull designs must have shop drawings submitted for approval of University Lock Shop Supervisor prior to fabrication.

## 2.21 ACCESSORIES FOR PAIRS OF DOORS

- A. Carry-Open Bars: Provide carry-open bars for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
  - 1. Material: Satin chrome plated, or dark bronze as scheduled, with strike plate.
- B. Flat Overlapping Astragals: Flat metal bar, surface mounted on face of door with tamper proof screws; minimum 1/8 inch (3.2 mm) thick by 2 inches (50 mm) wide by full height of door; and base metal as follows:

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1. Base Metal: Dark bronze anodized, painted steel, or stainless steel, as scheduled.
- C. Rigid, Housed Meeting Stile Astragals: Gasket material held in place by metal housing; fastened to face of door with screws.
  1. Gasket Material: Nylon brush.
  2. Housing Material: Aluminum, or dark bronze anodized, as scheduled.
  3. Manufacturers:
    - a. Specified: Pemko 29324\_NB.
    - b. Alternate: National Guard, Zero.
- D. Overlapping-with-Gasket Astragals: T-shaped metal, surface mounted on edge of door with screws; with integral gasket and base metal as follows:
  1. Base Metal: Aluminum, or dark bronze anodized, as scheduled.
  2. Gasket Material: Silicone.
  3. Manufacturers:
    - a. Specified: Pemko 355\_S.
    - b. Alternate: National Guard, Zero.
- E. Coordinators: BHMA A156.3.
  1. Bar type mounted on frame stop soffit, complete with filler bar and mounting brackets, painted to complement finish of other scheduled door hardware.
  2. Manufacturers:
    - a. Specified: Door Controls International.
    - b. Alternate: IVES Hardware; an Allegion Company, Rockwood; an ASSA ABLOY Company; Trimco, Triangle Brass Manufacturing Company.

## 2.22 CLOSERS, GENERAL

- A. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the 2020 Department of Justice "ADA Standards for Accessible Design" and U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and ANSI A117.1. Comply with the following maximum opening-force requirements:
  - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
  - b. Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.
  - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction, not to exceed maximum of 15 pounds.
- B. Hold-Open Closers/Detectors: Coordinate and interface integral smoke detector and closer device with fire alarm system.

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- C. Power-Assist Closers: As specified in Division 08 71 13 Section "Automatic Door Operators" for access doors for people with disabilities or where listed in door hardware sets.
- D. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory multi-sized closers, adjustable to meet field conditions and requirements for opening force.
- E. Surface Closers: BHMA A156.4, Grade 1. Listed under Category C in BHMA's "Certified Product Directory." Provide type of arm required for closer to be located on non-public side of door, inside rooms, stairs and interior of building.
  - 1. Manufacturers:
    - a. Specified: LCN Closers (model 4040XP/4041DEL); an Allegion Company.
      - 1) Inswinging Doors with closer mounted on pull side:
        - a) Furnish 4040XP/4041DEL to 120-degrees.
        - b) Furnish TJ4040XP-T x 4040T-18TJ at 180-degrees.
      - 2) Outswing doors with closer mounted on push side:
        - a) Furnish 4040XP-EDA
      - 3) Smaller width leaf of unequal pairs:
        - a) Furnish LCN 4031 Series (Use ST-3507 for inswinging door).
    - b. Alternate: None.
  - 2. Student housing rooms only: Norton Door Controls (model 1601/1601BF Series); an ASSA ABLOY Group Company.
- F. Overhead Concealed Closers: Not allowed unless approved by USC Lock Shop Supervisor.
- G. Floor Concealed Closers: Not allowed unless approved by USC Lock Shop Supervisor.
- H. Closer Holder Release Devices: BHMA A156.15. Listed under Category C in BHMA's "Certified Product Directory."
  - 1. Life-Safety Type: On release of hold open, door becomes self-closing. Automatic release is activated by smoke detection system.
  - 2. Manufacturers:
    - a. Specified: LCN Closers; an Allegion Company.
    - b. Alternate: None.

## 2.23 CLOSERS

- A. Modern-Type-with-Cover Surface Closers: Non-handed, rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; with forged-steel main arm; enclosed in cover indicated; complying with the following:
  - 1. Mounting: Hinge side or Parallel arm, type as scheduled.
  - 2. Type: Delayed action closing, where scheduled.
  - 3. Back-check: Adjustable, effective between 60 and 85 degrees of door opening.

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4. Closing Power Adjustment: Fully-adjustable with at least 50 percent more than minimum tested value.
5. Cover Material: Molded plastic Aluminum Painted or Plated steel, as scheduled.
6. Arm Options: Furnish regular or parallel arm units as required to mount closer inside rooms or stairs.
7. Stop Arm Options: Furnish with separate concealed or surface mounted overhead stop where required to limit swing of door due to obstruction or where use of conventional wall or floor stop is prohibited.
8. Mounting Plates: Provide closer with drop and full decorative back plates, as required to properly mount unit to door and frame installation.
9. Rigid, Housed, Perimeter Gasketing not to be cut for installation of rim exit device strikes, closer frame brackets or any other surface applied hardware.

#### 2.24 PROTECTIVE TRIM UNITS, GENERAL

- A. Size: 2 inches (38 mm) less than door width on push side and 1 inch (13 mm) less than door width on pull side, by height specified in door hardware sets.
- B. Countersunk Fasteners: Manufacturer's standard machine or self-tapping screws.
- C. Metal Protective Trim Units: Furnish at reverse bevel doors in corridors and exterior doors, beveled on four sides; fabricated from the following material:
  1. Material: 0.050-inch- (1.3-mm-) thick stainless steel or bronze, type as scheduled.
  2. Manufacturers:
    - a. IVES Hardware; an Allegion Company.
    - b. Rockwood; an ASSA ABLOY Company.
    - c. Trimco, Triangle Brass Manufacturing Company.

#### 2.25 PROTECTIVE TRIM UNITS

- A. Armor Plates: 36 inches (914 mm) high by door width, with allowance for frame stops.
  1. Per NFPA-80 protection plates over 16 inches (406 mm) high shall bear a UL Listing.
    - a. Engraved, embossed, or stamped label will be required:
      - 1) Specified: Trimco KA050 Series "ULS".
      - 2) Alternate: Approved equal as listed above.
    - b. No adhesive type mylar or paper labels will be acceptable.
- B. Kick Plates: 10 inches (305 mm) high by door width, with allowance for frame stops.
- C. Mop Plates: 6 inches (152 mm) high by 1 inch (25 mm) less than door width.

#### 2.26 STOPS AND HOLDERS, GENERAL

- A. Stops and Bumpers: BHMA A156.16, Grade 1, unless Grade 2 is indicated.

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1. Provide at exterior doors; heavy-duty base unit 2-1/2 inch by 2-1/4 inch height floor stops with exterior pack three fastener machine screws by expansion anchors, or heavy-duty anti-vandal unit with flame resistant molded rubber two inch diameter by 3-1/2 inch height (Trimco 1209HA).
  2. Where floor type stop will present a pedestrian hazard furnish heavy-duty overhead concealed stop, or closer with integral stop, type as required.
  3. Furnish Trimco model 7280 floor stops at interior in-swing doors, Trimco model 7281 floor stops at doors with panic or exit devices.
  4. Wall stops not allowed unless approved by USC Lock Shop Supervisor.
  5. Do not mount floor stops where they will impede traffic. Where floor stops are not appropriate, provide overhead stops or holders.
- B. Mechanical Door Holders: BHMA A156.16, Grade 1 unless Grade 2 (Trimco 1260 Series).
- C. Silencers for Wood Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum 5/8 by 3/4 inch (16 by 19 mm); fabricated for drilled-in application to frame.
- D. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch (13 mm); fabricated for drilled-in application to frame. Silencers shall not be used at fire-rated frames.
- E. Manufacturers:
1. Specified: Trimco, Triangle Brass Manufacturing Company.
  2. Alternate: Ives Hardware; an Allegion Company; Rockwood, an ASSA ABLOY Company.
- F. Electromagnetic Door Holders: Coordinate with fire detectors and interface with fire alarm system for labeled fire door assemblies.
1. Listed under Category C in BHMA's "Certified Product Directory."
  2. Manufacturers:
    - a. Specified: Rixson Specialty Door Controls; an ASSA ABLOY Group Company.
    - b. Alternate: LCN; an Allegion Company.

## 2.27 STOPS AND HOLDERS

- A. Wall Bumpers: Not allowed unless approved by USC Lock Shop Supervisor.
- B. Rigid Floor Stops: Cast brass or bronze with rubber bumper; expansion-shield application.
- C. Electromagnetic Door Holders: BHMA A156.15, Grade 1; electromagnet attached to wall or floor as indicated, and strike plate attached to swinging door.
  1. Configuration: Wall-mounted single unit.

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2. Options: Provide adjustable length armature extension unit where required due to wall-depth.

## 2.28 OVERHEAD STOPS AND HOLDERS

- A. Overhead Concealed Slide Holders: BHMA A156.8, Type 1; hold open and release by push and pull of door unless control is set in inactive position; with stop and shock absorber; adjustable holding pressure; for single acting doors opening 110 degrees.
- B. Overhead Concealed Slide Stops: BHMA A156.8, Type 1; release by push and pull of door unless control is set in inactive position; with stop and shock absorber; adjustable holding pressure; for single acting doors opening 110 degrees.
  1. Manufacturers:
    - a. Specified: Rixson Specialty Door Controls; an ASSA ABLOY Group Company.
    - b. Alternate: Architectural Builders Hardware (ABH), Glynn-Johnson; an Allegion Company.

## 2.29 DOOR GASKETING, GENERAL

- A. Standard: BHMA A156.22. Listed under Category J in BHMA's "Certified Product Directory."
- B. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide non-corrosive fasteners for exterior applications and elsewhere as required for wet locations.
  1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
  2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
  3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.
- C. Air Leakage: Not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283 and UL1784.
- D. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.
  1. Provide smoke-labeled gasketing on S-labeled doors and at fire-rated doors.
- E. Fire-Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to Standard UL-10C.
  1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches (1016 mm) or less above the sill.

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- F. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408. Sound seals shall realize a 97% rating as tested under requirements of E90 and BS EN ISO 140-3
- G. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- H. Gasketing Materials: ASTM D 2000 and AAMA 701/702.
- I. Manufacturers:
  - 1. Specified: Pemko Manufacturing Co., an ASSA ABLOY Group company.
  - 2. Alternate: National Guard; Zero, an Allegion Company.

### 2.30 DOOR GASKETING

- A. Adhesive-Backed Perimeter Smoke Gasketing: Gasket material applied to frame rabbet with self-adhesive.
  - 1. Gasket Material: Silicone.
    - a. Pemko, an ASSA ABLOY Company
      - 1) Specified: Model S88, or S44 as required.
      - 2) Alternate: National Guard; Zero, an Allegion Company.
- B. Adhesive-Backed Perimeter Sound Gasketing: Gasket material applied to frame rabbet with self-adhesive.
  - 1. Gasket Material: Silicone.
    - a. Specified: Pemko, an ASSA ABLOY Company, one set model S773.
    - b. Alternate: National Guard; Zero, an Allegion Company.
- C. Rigid, Housed, Perimeter Gasketing: Gasket material held in place by metal housing; fastened to frame stop with screws.
  - 1. Gasket Material: Silicone.
    - a. Specified: Pemko, an ASSA ABLOY Company, model 2891\_S, type as scheduled.
  - 2. Alternate: National Guard; Zero, an Allegion Company. Housing Material: Clear anodized aluminum or dark bronze anodized aluminum, type as scheduled.
- D. Overlapping Astragals for Pair's Doors: Gasket material held in place by metal housing and overlapping when doors are closed; mounted to face of meeting stile with screws.
  - 1. Gasket Material: Silicone bulb.
  - 2. Housing Material: Clear anodized aluminum, dark bronze anodized aluminum or stainless steel, type as scheduled.
  - 3. Mounting: Surface mounted to one door.
- E. Meeting Astragals for Meeting Stiles: Gasket material held in place by metal housing; mounted with screws.



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1. Gasket Material: Nylon brush.
    - a. Specified: Pemko, an ASSA ABLOY Company, model 29324\_NB.
    - b. Alternate: National Guard; Zero, an Allegion Company.
  2. Housing Material: Clear anodized aluminum or dark bronze anodized aluminum, type as scheduled.
  3. Mounting: Surface mounted on face of each door. Miter bottom of astragal and leading edge of door sweep at 45-Degree angle.
- F. Door Sweeps: Gasket material held in place by flat metal housing or flange; surface mounted to face of door with screws, concealed by smooth extruded housing.
1. Gasket Material: Nylon brush.
    - a. Specified: Pemko, an ASSA ABLOY Company, model 57\_V.
    - b. Alternate: National Guard; Zero, an Allegion Company.
  2. Housing Material: Clear anodized aluminum or dark bronze anodized aluminum, type as scheduled.
- G. Automatic Door Bottoms: Gasket material held in place by metal housing that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.
1. Gasket Material: Sponge silicone.
  2. Housing Material: Clear anodized aluminum, or dark bronze anodized aluminum, type as scheduled.
  3. Mounting: Mortised into bottom of door, type as scheduled.
  4. Type: Low-closing-force type for doors required to meet accessibility requirements.

## 2.31 THRESHOLDS, GENERAL

- A. Standard: BHMA A156.21. Listed under Category J in BHMA's "Certified Product Directory."
- B. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." ANSI A117.1 and CBC Chapter Eleven Accessibility.
1. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
- C. Manufacturers:
1. Specified: Pemko Manufacturing Co., an ASSA ABLOY Group company.
  2. Alternate: National Guard; Zero, an Allegion company.

## 2.32 THRESHOLDS

- A. Saddle Thresholds: Type and base metal as follows:
1. Type: Smooth top, Fluted top, type as scheduled.
  2. Base Metal: Aluminum or dark bronze anodized aluminum, type as scheduled.

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- B. Half-Saddle / Offset Thresholds: Fluted-top metal member; and base metal of aluminum with beveled slope on one side, not steeper than 1:2 inch slope.
  - 1. Base Metal: Aluminum or dark bronze anodized aluminum, type as scheduled.

### 2.33 FOLDING AND SLIDING DOOR HARDWARE, GENERAL

- A. General: BHMA A156.14; consisting of complete sets including overhead rails, hangers, supports, bumpers, floor guides, and accessories indicated.
  - 1. Interior Doors: Provide door hardware for interior bi-folding and bi-passing doors when not furnished as part of door package.
- B. Bi-folding and Sliding Door Hardware: Rated for door panels weighing up to 300 lb.
- C. Multiple Folding and Sliding Door Hardware: Rated for door panels weighing up to 600 lb.
- D. Opening force must comply with Accessibility Requirements.
- E. Track assembly must have dampers that slow end of opening/closing cycle to prevent injury.
- F. Track assembly to be side or head installed as required.
- G. Furnish end caps and fascia as required.
- A. Component manufacturers:
  - 1. Specified: KN Crowder Catch'N'Close
  - 2. Alternate: None.
- B. System assembly manufacturers:
  - 1. Specified: KN Crowder "Crowder Slide"
  - 2. Alternate: None.

### 2.34 FOLDING AND SLIDING DOOR HARDWARE

- A. Door Hardware: Rails and door hardware that allow horizontal and vertical adjustment.
  - 1. Rail Material: Galvanized wrought steel or aluminum as specified.
  - 2. Rail Configuration: I-beam.
  - 3. Mounting: Surface mounted overhead.
  - 4. Wheel Assembly: Two wheel or four wheel, with roller bearings.
  - 5. Wheel Material: Steel or nylon as specified.
- B. Multiple Door Hardware: Rails and door hardware that allows horizontal and vertical adjustment.
  - 1. Rail Material: Galvanized wrought steel.
  - 2. Rail Configuration: I-beam.

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3. Mounting: Surface mounted overhead.
4. Wheel Assembly: Two wheel or four wheel, with roller bearing.
5. Wheel Material: Steel or nylon as specified.

## 2.35 FABRICATION

- A. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.
- B. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
  1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt, painted to match door face.
  2. Steel Machine or Wood Screws: For the following fire-rated applications:
    - a. Mortise hinges to doors.
    - b. Strike plates to frames.
    - c. Closers to doors and frames.
  3. Steel Through (SNB) Bolts: University generally requires concealed fasteners to be specified, unless Manufacturers' installation requires use of through-bolts. The following fire-rated applications may require use of sex-nut bolts unless door blocking is provided:
    - a. Surface hinges to doors.
    - b. Through-Bolt attachments will not be allowed on door closers. Coordinate with door manufacturers to provide the proper reinforcement or blocking to prevent the use of through-bolts.
    - c. Surface-mounted exit devices.
  4. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."

## 2.36 FINISHES

- A. Standard: BHMA A156.18, finish as selected by project designer and indicated in door hardware sets.
  1. Default finishes shall be BHMA 652 (Satin Chrome), BHMA 626 (Satin Chrome) or BHMA 630 (Satin Stainless Steel).

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2. Alternate: Where required to match existing building standards for dark bronze finishes furnish BHMA 613e, Von Duprin 643e.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Unless otherwise indicated, finishes shall conform to those identified in ANSI/BHMA A156.18. Comply with base material and finish requirements indicated by the following:
1. BHMA 600: Primed for painting, steel base metal.
  2. BHMA 606: Satin brass, clear coated, brass base metal.
  3. BHMA 613: Dark-oxidized satin bronze, oil rubbed, bronze base metal.
  4. BHMA 626: Satin chromium plated over nickel, brass or bronze base metal.
  5. BHMA 627: Satin aluminum, clear coated, aluminum base metal.
  6. BHMA 628: Satin aluminum, clear anodized, aluminum base metal.
  7. BHMA 630: Satin stainless steel, stainless-steel base metal.
  8. BHMA 640: Dark-oxidized satin bronze plated over copper plate, oil rubbed, steel base metal.
  9. BHMA 652: Satin chromium plated over nickel, steel base metal.
  10. BHMA 682: Satin chromium plated over nickel, zinc base metal.
  11. BHMA 689: Aluminum painted, any base material.
  12. BHMA 695: Dark bronze painted, any base material.
  13. BHMA 710: Dark-oxidized satin bronze anodized, aluminum base metal.
  14. BHMA 718: Satin aluminum, uncoated, aluminum base metal.
  15. BHMA 719: Mill finish aluminum, uncoated, aluminum base metal.
  16. BHMA 722: Dark-oxidized bronze, oil rubbed, architectural bronze base metal.

## PART 3 - EXECUTION

### 3.1 SPECIAL INSTRUCTIONS

#### A. Emergency Exiting Requirements

1. Free Egress at Controlled Doors: Electrically controlled doors shall be operable from the secured side without the use of access cards, keypads or requiring any special knowledge. Mechanical Request-To-Exit (REX) switches integral with door hardware shall sense a person needing egress and automatically bypass the alarm function. Motion or Passive Infrared Sensors will not be allowed.
  - a. Doors equipped with electrified Mortise Locks or Electrified Exit Hardware:

- 1) The hardware configuration on access controlled doors shall enable egress without requiring electrical release of its associated mortise lock or electrified exit device.
  - 2) Door handles on the egress side shall retract latch bolt from the strike.
  - 3) The access system shall detect the normal egress of a user at any individual portal with a Request To Exit switch built directly into the mechanism used to egress and shall bypass any alarm associated with the portal for an individually programmable duration.
- b. Stairwell Door Locks:
- 1) Stairwell doors which are locked from the stairwell side shall have the capability to be unlocked simultaneously upon a signal from the Fire Command Center and the Security Command Center.
  - 2) Stairwell locking systems shall comply with the requirements of the applicable Building Code relating to Means of Egress.
  - 3) Contractor shall provide clearly labeled switches in the required locations to unlock all stairwell doors simultaneously. Coordinate wall or desk mounted switch style with the University and the Authority Having Jurisdiction.
  - 4) This interface shall not depend on the EACS Host or Remote Controllers for its operation. Locate interface relays for each stairwell door electrically ahead of EACS lock control to independently override EACS control.
2. Request-To-Exit Activation: Request-To-Exit devices shall always be connected to EACS inputs for processing and control. Independent Request-To-Exit devices shall never be connected directly to electrified locks, local control relays, or power supplies.
3. Mechanical Lock Operation: Electrified locks shall be mechanically keyed to permit manual unlocking in an emergency. Mechanical operation shall not override door monitoring functions.
4. Lock Failure Configuration:
- a. Electrified Stairwell Locks: Electrified stairwell locks, including panic hardware that is locked in the direction of egress, shall be configured as fail-safe, i.e.: the lock shall lock only when powered. Coordinate the selected hardware with the University to assure its suitability for the purpose intended.
  - b. Other electrified locks: All other electrified locks and exit devices shall be configured as fail-secure, i.e.: the lock or exit device shall unlock only when powered. Coordinate the selected hardware with the University to assure its suitability for the purpose intended.

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5. Fire Alarm Interface: Electrified locks and exit hardware which are a part of this work and which are locked in the path of legal exiting shall be connected to the building Fire Alarm System in accordance with University requirements such that they automatically unlock in the event of activation of the Fire Alarm System. This shall occur whether the activation is a result of a manual pull station, smoke detector or sprinkler flow switch.
  - a. A fire alarm "general/common alarm relay" shall be programmed at the fire alarm control panel to activate the EACS interface relays located in each Lock Power Supply cabinet. The Contractor shall research and provide all necessary fire alarm system conduit, wire, hardware and programming to perform the required interface.
  - b. This interface shall not depend on the EACS Host or Remote Controllers for its operation. Locate these interface relays electrically ahead of lock power distribution as shown on the drawings. The Contractor shall supply and install programmed alarm interface relay(s) with sufficient capacity to control the power supplied to all controlled locks under Division 28.

### 3.2 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance. Notify Architect of any incompatibilities, prior to commencing affected work.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 Series.
  1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.
- B. Wood Doors: Comply with DHI A115-W Series.

### 3.4 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.
  1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

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2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
  3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
  4. Bottom Hinge: 10 inches from door bottom to bottom of hinge.
  5. Top Hinge: 5 inches from door top to top of hinge.
  6. Center Hinge(s) or Pivot(s): Spaced equidistantly between top and bottom hinges/ pivots.
  7. Lockset / Latchset: 38 inches from finished floor to center of lever.
  8. Hospital Push-Pull Latchset/ Lockset: 42 inches from finished floor to center of latch.
  9. Exit Device: 38 inches from finished floor to device centerline.
  10. Deadlock: Maximum height of 44 inches from finished floor to center key cylinder / thumb turn.
  11. Push Plate/ Pull Plate: 42 inches from finished floor to center of pull.
  12. Floor Stop: Adjacent to wall; not to exceed 4 inches from face of wall; located 3 inches from latch edge of door; in any case never more than 50 percent of door width from latch edge of door.
  - 13.
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
  2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
  3. Set units to allow maximum door swing, unless door encounters obstruction. In such case install hardware to allow minimum 90 degree swing, set to limit from encountering obstruction.
  4. When hardware is to be attached to existing metal surface and insufficient reinforcement exists, use Riv-Nuts, Nut-Serts, or similar anchoring device fasteners.
- C. Door Closers: Install door closers inside rooms, stairs and within building interior, with fasteners that are not exposed on door. Coordinate with Wood Door Division to insure doors are supplied with required top rail blocking reinforcement to enable non-through bolted installation. For special doors where blocking reinforcement construction is not available furnish closer with sex-nut bolt sleeve fasteners, painted to match door face finish.
- D. Power Supplies: Locate power supplies as indicated, in equipment rooms. Verify location with Architect. Furnished and installed by Division 28.
1. Configuration: Provide the least number of power supplies centrally located, required to adequately serve doors with electrified door hardware.
- E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants." Install thresholds with ¼ - 20 Stainless steel or dark bronze machine screws, type as scheduled and expansion shields.

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- F. Floor Stop: Adjacent to wall; not to exceed 4 inches from face of wall; located 3 inches from latch edge of door; in any case never more than 50 percent of door width from latch edge of door.
- G. Rigid, Housed, Perimeter Gasketing not to be cut for installation of rim exit device strikes, closer frame brackets or any other surface applied hardware.

### 3.5 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: General Contractor to coordinate with Architect who will engage a University Basis-of-Design approved Independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
  - 1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted, and prepare a specific list of any deficiencies, a copy of which shall be provided to the Architect.
  - 2. Contractor shall correct all deficiencies noted in above report.
  - 3. Independent Architectural Hardware Consultant shall re-inspect door hardware and prepare a report certifying correction of deficiencies and compliance with requirements.

### 3.6 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
  - 1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
  - 2. Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
  - 3. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, General Contractor shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

### 3.7 CLEANING AND PROTECTION

- A. Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products.



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- B. Clean adjacent surfaces soiled by door hardware installation. Remove construction debris from project site and legally dispose of debris.
- C. Clean installed products in accordance with manufacturer's instructions prior to University's acceptance.
- D. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

### 3.9 FINAL PROCEDURES

- A. Perform final procedures in accordance with
  - 1. Section 28 05 00, Security General Requirements.
- B. Independent Fire and Egress Door Assembly Inspector (FEDAI), certified by the Door & Hardware Institute (DHI) and audited as an Intertek Qualified Personnel (IQP), shall inspect new and existing fire and egress swinging doors with Builders Hardware after any required corrective actions performed in accordance with NFPA-80, NFPA-101, NFPA-105.
  - 1. Issue report in format approved by University to be used for subsequent Annual Fire and Egress door inspection requirements.

### 3.8 DOOR HARDWARE SCHEDULE (SETS)

**(TO BE ENGINEERED FOR SPECIFIC PROJECT BY DHI CERTIFIED AHC AS DESIGNATED)**

END OF SECTION 087101

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## SECTION 08 71 02

### DOOR HARDWARE – HSC Guide Specification for Capital Construction

*[Adjust to Suit Project and Confirm with University Lock Shop; Conform to Architect's format]*

#### PART 1 - GENERAL

##### 1.1 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of Division 01 and Section 28 05 00 Specification Sections, apply to this Section.
- B. CALgreen Submittals:
  - 1. Product Data for Section 5.504.4.1: For sealants, adhesives and caulks, provide documentation including printed statement of VOC content showing compliance with SCAQMD Rule 1168 VOC limits and CCR Title 17 for aerosols.
  - 2. Product Certificates for Section A5.405.1: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. For the purposes of this requirement, "regional" is interpreted to mean within 500 miles of the project location or within the State of California.

##### 1.2 SUMMARY

- A. This Section includes the following :
  - 1. Door hardware for the following:
    - a. Swinging doors.
    - b. Non-fire-rated sliding doors.
    - c. Non-fire-rated folding doors.
    - d. Other doors to the extent indicated.
  - 2. Interior Curtainwall and Interior Storefront Door hardware.
  - 3. Exterior Fiberglass Composite Door Hardware.
  - 4. Electrified door hardware, including electric locking and release hardware, low voltage power supplies for electric hardware and wall or floor mounted electromagnetic hold-open devices
  - 5. Cylinders for doors specified in other Sections.
  - 6. Padlocks
- B. Related Sections include the following:
  - 1. Section 08 11 13 "Hollow Metal Doors and Frames" for astragals provided as part of fire-rated labeled assemblies.

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2. Section 08 17 00 "Integrated Door Opening Assemblies" for integral inset exit device hardware factory installed into Hollow Metal Doors.
  3. Section 08 14 16 "Flush Wood Doors" for integral intumescent seals provided as part of fire-rated labeled assemblies.
  4. Section 08 16 13 Section "Fiberglass Composite Exterior Entrances and Exterior Storefronts" for entrance door hardware, except cylinders.
  5. Section 08 41 13 Section "Aluminum-Framed Interior Entrances and Interior Storefronts" for entrance door hardware, except cylinders.
  6. Division 08 Section "Overhead Coiling Doors" for door hardware provided as part of overhead door assemblies.
  7. Division 08 Section "Overhead Coiling Grilles" for door hardware provided as part of overhead grille assemblies.
  8. Division 08 Section "Sound Control Door Assemblies" for hinges and gasketing provided as part of sound-rated door assemblies.
  9. Division 08 Section "Automatic Entrances".
  10. Section 08 71 13 Section "Automatic Door Operators".
  11. Section 07 92 00 "Joint Sealants"
  12. Division 26 Sections for connections to electrical power system and for low-voltage wiring work.
  13. Division 28 Section "Access Control" for access control devices installed at door openings and provided as part of a security access system.
  14. Division 28 Section "Intrusion Detection" for detection devices installed at door openings and provided as part of an intrusion detection system.
  15. Division 28 Section "Fire Detection and Alarm" for connections to building fire alarm system.
  16. Section 28 05 00 Security General Requirements
- C. The General Contractor shall furnish and install door hardware devices, locks, hinges and other components of the system as shown and specified, including termination of wiring.
1. Electrified mortise locks.
  2. Electrified emergency exiting hardware.
  3. Electrical locking system accessories.
- D. The Contractor shall coordinate door hardware requirements with the University to achieve the specified operation of the Access Control System.
- E. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
1. Cylinders for locks specified in other Sections.
  - 2.
- F. Products furnished and installed by others.
1. Permanent cylinder cores to be furnished and installed by University Lock Shop.
  2. Centralized power supplies furnished and installed by Division 28.
  3. Card Readers furnished and installed by Division 28.
  4. Door Position Switches furnished and installed by Division 28.

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### 1.3 REFERENCES

#### A. Use date of standard in effect as of Bid date:

1. (ADA) - Americans with Disabilities Act of 1990.
2. (ANSI A117.1) - American National Standards Institute, Accessible and Usable Buildings and Facilities.
3. (ANSI) American National Standards Institute/ (BHMA) – Builders Hardware Manufacturers Association :
  - a. ANSI/BHMA A156.1 Standard for Butts and Hinges.
  - b. ANSI/BHMA A156.2 Standard for Bored Locks & Latches.
  - c. ANSI/BHMA A156.3 Standard for Exit Devices.
  - d. ANSI/BHMA A156.4 Standard for Door Closers.
  - e. ANSI/BHMA A156.5 Standard for Auxiliary Locks and Associated Products.
  - f. ANSI/BHMA A156.6 Standard for Architectural Door Trim.
  - g. ANSI/BHMA A156.7 Standard for Template Hinge Dimensions.
  - h. ANSI/BHMA A156.8 Standard for Door Controls – Overhaed Stops and Holders.
  - i. ANSI/BHMA A156.13 Standard for Mortise Locks & Latches.
  - j. ANSI/BHMA A156.14 Standard for Sliding and Folding Door Hardware.
  - k. ANSI/BHMA A156.15 Standard for Release Devices: Closer Holders, Electromagnetic and Electromechanical.
  - l. ANSI/BHMA A156.16 Standard for Auxiliary Hardware.
  - m. ANSI/BNMA A156.17 Standard for Self-Closing Hinges and Pivots.
  - n. ANSI/BHMA A156.18 Standard for Materials & Finishes.
  - o. ANSI/BHMA A156.19 Standard for Power Assist & Low Energy Power Operated Doors.
  - p. ANSI/BHMA A156.21 Standard for Thresholds.
  - q. ANSI/BHMA A156.22 Standard for Door Gasketing Systems.
  - r. ANSI/BHMA A156.23 Standard for Electromagnetic Locks.
  - s. ANSI/BHMA A156.24 Standard for Delayed Egress Locks.
  - t. ANSI/BHMA A156.25 Standard for Electrified Locking Devices.
  - u. ANSI/BHMA A156.26 Standard for Continuous Hinges.
  - v. ANSI/BHMA A156.28 Standard for Recommended Practices for Mechanical Keying Systems.
  - w. ANSI/BHMA A156.29 Standard for Exit Locks, Exit Locks with Exit Alarms, Exit Alarms, Alarms for Exit.
  - x. ANSI/BHMA A156.30 Standard for High Security Cylinders.
  - y. ANSI/BHMA A156.31 Standard for Electrified Strikes and Frame Mounted Activators.
  - z. ANSI/BHMA A156.32 Standard for Integrated Door Opening Assemblies.
  - aa. ANSI/BHMA A156.36 Standard for Auxiliary Locks.
  - bb. ANSI/BHMA A156.41 Standard for Door Hardware Single Motion to Egress.
  - cc. ANSI/BHMA A156.115 Standard for Hardware Prepartaion in Steel Doors with Steel Frames.
  - dd. ANSI/BHMA A156.115W Standard for Hardware Preparation in Wood Doors with Wood or Steel Frames.
4. (DHI) - Door Hardware Institute.
  - a. DHI A115.1G Installation Guide for Doors and Hardware.
  - b. DHI Recommended Sequence and Format for the Hardware Schedule.

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- c. DHI Keying Systems and Nomenclature.
5. (DOJ) – Department of Justice.
  - a. ADA Standards for Accessible Design.
6. (NFPA) – National Fire Protection Association:
  - a. NFPA 80 Fire Doors and Other Opening Protectives.
  - b. NFPA 101 Life Safety Code
  - c. NFPA 105 Smoke Door Assemblies and Other Opening Protectives
7. d. NFPA 252 Fire Tests of Door Assemblies. (SDI) – Steel Door Institute:
  - a. SDI 100 Recommended Specifications for Standard Steel Doors and Frames.
  - b. SDI 122 Installation of Standard Steel Doors and Frames.
8. (UL) – Underwriters Laboratories Inc.:
  - a. UL10C Positive Pressure Fire Tests of Door Assemblies.
  - b. UL294 Standard for Access Control System Units.
  - c. UL305 Panic Hardware.
  - d. UL437 Drill and Pick Resistant Key Cylinders.
  - e. UL1034 Burglary-Resistant Electric Locking Mechanisms.
  - f. Standards for Electrified Locking Equipment and Power Supplies.
  - g. UL1784 Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives.
9. (WDMA I. S. 1A) – Window and Door Manufacturers Association, Industry Standard for Architectural Wood Flush Doors.
10. (WHI) – Warnock Hersey Incorporated (Intertek or ITS)

B. Abbreviations

1. EACS – Electronic Access Control System
  - a. Refer to Section 28 05 00

#### 1.4 REGULATORY REQUIREMENTS

A. Conform to the following:

1. (CBC) - California Building Code.
2. (CFC) – California Fire Code.
3. (Title 24, CCR) - California Building Standards Reference Code.
4. (LABC) – City of Los Angeles Building Code.

#### 1.5 SHOP DRAWINGS AND SUBMITTALS

- A. In accordance with Section 01 33 00 Submittal Procedures and Section 28 05 00, Security General Requirements.
- B. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. Shop Drawings: Details of electrified door hardware, indicating the following:

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1. Wiring Diagrams: Power, signal, and control wiring. Furnished by Division 28.
2. Description and Sequence of Operation of each electrified door hardware function.
  - a. Furnished by Division 28.
  - b. General Contractor to coordinate with Division 28.
- D. Product Certificates: For electrified door hardware, signed by product manufacturer.
  1. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.
- E. Qualification Data: For Consultant per Part 1.7.B.
- F. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware schedule.
- G. Warranty: Provide manufacturer printed warranty data.
- H. Other Action Submittals:
  1. Door Hardware Schedule (Sets): Submit one electronic copy or six hard copies prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
    - a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
    - b. Format: Use same scheduling sequence and use same door numbers as in the Contract Documents.
    - c. Content: Include the following information:
      - 1) Identification number, location, hand, fire rating and material of each door and frame. Door identification numbers shall conform to University Basis-of-Design as follows:
        - a) All rooms with doors are to be identified by room number followed by a dot and number (i.e. 101.1).
        - b) Where there are two or more doors in a room use numeric sequence.
        - c) The numbers for stair wells and corridors/lobbies/vestibules shall use the established standard:  
1<sup>st</sup> Character: Alpha code identifying Stairs (S); Corridors (C)  
2<sup>nd</sup> Character: Floor code (i.e. B, P, R, 1, 2, 3, 4, etc.)  
3<sup>rd</sup> Character for Stairs: Use a number for the space identifier (i.e. S11 = Stairs, 1<sup>st</sup> Floor, Stair #1)  
3<sup>rd</sup> Character for Corridors: Use an alpha for space identifier (A, B, C, D, Etc.; i.e. C1A = Corridor, 1<sup>st</sup> Floor, #A

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- 2) Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device.
  - 3) Complete designations of every item required for each door or opening including name and manufacturer.
  - 4) Fastenings and other pertinent information.
  - 5) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
  - 6) Explanation of abbreviations, symbols, and codes contained in schedule.
  - 7) Mounting locations for door hardware.
  - 8) Degree of swing for each door.
  - 9) Door and frame sizes and materials.
  - 10) Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
    - a) Sequence of Operation: General Contractor to coordinate with Division 28.
  - 11) List of related door devices specified in other Sections for each door and frame.
- d. Submittal Sequence: Submit the final door hardware schedule with sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.
2. Keying Matrix : General Contractor to furnish a keying matrix immediately following Keying Conference under 1.7.F to be conducted a minimum of three months prior to Temporary Certificate of Occupancy (TCO) in a format provided by Univeristy.

## 1.6 DOOR REQUIREMENTS

- A. Door Position Switches shall be furnished and installed by the Security Contractor.
- B. Mechanical Request-To-Exit (REX) switches required at all exterior doors and all doors with electrified hardware, except for electro-magnetic door holders.
- C. Electrical Power Transfers (EPT) required at all exterior doors and doors with panic exit devices.
- D. All rooms must be capable of being lockable to method defined by University standards.
  1. All conference rooms to lock unless located within a lockable suite.
- E. Classroom Security Per University Door Hardware Matrix or Method prescribed by USC Lock Shop per specific project:
  1. New and existing hardwired Networked Card Reader/Electrified Hardware:

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- a. Furnish SDC 434KLDURL2 Lockdown button(s) on inside of classroom at each egress door and non-egress side(s) walls, as required.
      - 1) STI-6518 Flip Cover.
    - b. Remote Lockdown capabilities.
  2. New and existing WiFi enabled or standalone Schlage AD400 Access Control Locksets on Lenel:
    - a. Furnish SDC 434KLDURL2 Lockdown button(s) on inside of classroom at each egress door and non-egress side(s) walls, as required.
      - 1) STI-6518 Flip Cover.
    - b. Remote Lockdown capabilities.
  3. Existing standalone Schlage AD200/Omnilocks and Mechanical Classroom Function Locksets.
    - a. Furnish the following on inside of room:
      - 1) SDC 1500 Series Magnetic Lock
      - 2) SDC 602RF x RB12V4 Power Supply
      - 3) SDC 423MU Exit Button
      - 4) SDC 434KLDURL2 Lockdown button(s) on inside of classroom at each egress door and non-egress side(s) walls, as required.
        - a) STI-6518 Flip Cover.
      - 5) Field modify existing egress side mechanical operating hardware with mechanical Request-To-Exit (REX) switch
      - 6) Local Lockdown only; No remote Lockdown capabilities
    - b. Furnish the following on outside of room:
      - 1) SDC 700 Series Key Switch
      - 2) Campus Standard Mortise Cylinder for access only by DPS
  4. No substitutions allowed without prior approval of Lock Shop Supervisor
- F. Delayed Egress Systems:
  1. When Delayed Egress Systems are required the following shall be used:
    - a. Delayed Egress Electromagnetic Lock: Security Door Controls (SDC) Integrated Exit Check 1511(S/T)-NC-KV-L-D-B-A-V1
    - b. Delayed Egress Controller: Security Door Controls (SDC) 101-AK
    - c. Power Supply: Security Door Controls (SDC) 630RF Series
      - 1) Mortise Cylinder: USC Lock Shop to verify required cylinder housing
      - 2) Permanent Cylinder Core: To be furnished by USC Lock Shop
  2. Delayed Egress System activated by Request-to-Exit (REX) switch in exit device or mortise lock. Von Duprin Chex-It Delayed Egress Exit Device not allowed.
  3. Shunt by card reader and door position switch furnished by Security Contractor.
- G. Interlocks
  1. When Interlocks are required the following shall be used:
    - a. Inside of Room:
      - 1) Magnetic Lock(s): Security Door Controls (SDC) 1511-V-D-B-TJ1
      - 2) Power Supply: Security Door Controls (SDC) 632RF x UR4-8 x RB12V7
      - 3) LED Status Indicator(s): Security Door Controls (SDC) 400U-L2-Red/Grn
      - 4) Emergency Door Release: Safety Technology Intl (STI) STI-2048EM-EN
    - b. Outside of Room:
      - 1) Maintained Key Switch: Security Door Controls (SDC) 700UL1-Red
      - 2) Mortise Cylinder: USC Lock Shop to verify required cylinder housing

Note: Footer to conform with Architect's format.



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- 3) Permanent Cylinder Core: To be furnished by USC Lock Shop
    - c. System Point-to-Point Wiring Diagram by Security Door Controls (SDC)
  2. No substitutions allowed without prior approval of Lock Shop Supervisor.
- H. Roof Doors to/from Stair
1. All roof doors to conform with LAFD Fire Prevention & Public Safety Bureau Requirement #102.
  2. Existing Roof Door
    - a. Existing hollow metal door and frame to remain.
      - 1) Properly fill, repair and patch any unused holes or preparations.
      - 2) Field verify 90-Minute fire labels are intact and readily visible.
      - 3) Field verify glazing and tape in vision lite is intact with no breaks.
      - 4) Field verify tolerances meet NFPA-80 for fire doors.
        - a) Perform necessary corrective actions.
    - b. Following existing hardware to remain, unless corrective active required:
      - 1) Butt Hinges:
        - a) Field verify hinges have stainless steel base metal and have non-removable pins (NRP) or replace with Hager BB1191 4.5 x 4.5 x NRP x 630.
        - b) Field verify if thru-wired power transfer hinge is required or replace with Command Access Technologies ETH-2WH 4.5 x 4.5 x 630.
      - 2) Continuous Hinge:
        - a) Field install Security Door Controls Electrical Power Transfer PT-5.
      - 3) Exit Device:
        - a) Field verify UL Labeled as "Fire Exit Hardware"
        - b) Exit device bar on stair side replace lever trim with Command Access Technologies V96BE-REE-L6 or Von Duprin BE-RX996L-06.
        - c) Exit device bar on roof side add Command Access Technologies REX switch VDREXKIT-ED.
      - 4) Mortise Lock:
        - a) Remove existing mortise lock and replace with mortise passage latchset (Yale 8801FL @ HSC or Corbin-Russwin ML2010 @ UPC).
        - b) Factory install at Command Access Technologies Request-to-Exit REX switch on roof side lever.
      - 5) Cylindrical Lock:
        - a) Remove existing cylindrical lock and replace with cylindrical passage latchset Yale AU5401.
        - b) Factory install at Command Access Technologies Request-to-Exit REX switch on roof side lever.
      - 6) Surface Closer:
        - a) Field verify existing door closer is intact and in good condition or replace with LCN 4040XP-SCUSH.
      - 7) Perimeter Head and Jamb Seals; Door Bottom/Sweep:
        - a) Field verify existing seals and door bottom/sweep are intact and in good condition or replace with products listed under Part 2.30.
    - c. Following new door hardware to be furnished and installed:
      - 1) Install Security Door Controls Magnetic Lock 1571 D-BAS-V on stair side
      - 2) Install Security Door Controls Emergency Door Release 492 x 492-BB on stair side wall adjacent to door

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- 3) Install Security Door Controls Power Supply 602RF 120VAC on stair side
- 4) Install Security Door Controls Mushroom Exit Button 446U Series x 630 on roof side wall adjacent to door
  - a) Install mushroom exit button on roof side into wall mounted Safety Technology International Waterproof Cover STI-1350 x Custom Warning Label
- d. Access Control
  - 1) Card Reader/Intercom to be installed on stair side
    - a) Replace existing card reader with Lenel reader 2 N Intercom with Camera
  - 2) Fire alarm interface on Lenel Panel
    - a) Verify existing to remain or install new interface
    - b) Network drop to roof stair terminal can
    - c) Add new rated backboard and power supply
    - d) Run network cable, outside push button conduit and provide pathway for fire alarm tie in
    - e) Install jack in 6x6 terminal can near door with the sounder mounted to it
    - f) Field verify existing door position switch is intact and operational
- e. Signage and Operational Intent
  - 1) Existing Roof side illuminated EXIT sign to remain
  - 2) Existing Stair side signage to be removed
  - 3) New Stair side signage and Operational Intent
    - a) Door locked when powered
    - b) Not an exit
    - c) Door will unlock upon emergency door release, fire alarm or loss of power
    - d) Proper credential will unlock momentarily and rearm
    - e) Two-Way communication and remote release
  - 4) New Roof side signage and Operational Intent
    - a) Door locked when powered
    - b) Depressing lever handle will activate switch which momentarily deactivates power to magnetic lock for egress into building
    - c) Emergency wall mounted mushroom button will also momentarily deactivate power to magnetic lock if lever handle switch is not successful
    - d) Door will unlock upon fire alarm or loss of power
3. New Roof Door
  - a. 90-Minute S fire labeled 16-gage continuously welded hollow metal frame.
  - b. 90-Minute S fire labeled 16-gage steel stiffened hollow metal door.
  - c. Door hardware:
    - 1) Butt Hinges:
      - a) Heavy Weight stainless steel base metal (Hager BB1199 4.5 x 4.5 x NRP x 630, or approved equal).
      - b) Heavy Weight stainless steel base metal thru-wired power transfer hinge (Hager BB1199ETW 4.5 x 4.5 x 630, or approved equal).
    - 2) Mortise Passage Latchset:
      - a) Yale 8801FL @ HSC or Corbin-Russwin ML2010 @ UPC.

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- b) Factory install at Command Access Technologies Request-to-Exit REX switch on roof side lever.
- 3) Surface Closer: LCN 4040XP-SCUSH.
- 4) Perimeter Head and Jamb Seals; Door Bottom/Sweep:
  - a) Products listed under Part 2.30.
- 5) Threshold per Architectural sill detail as required for condition.
- d. Electrical Hardware:
  - 1) Install Security Door Controls Magnetic Lock 1571 D-BAS-V on stair side
  - 2) Install Security Door Controls Emergency Door Release 492 x 492-BB on stair side wall adjacent to door
  - 3) Install Security Door Controls Power Supply 602RF 120VAC on stair side
  - 4) Install Security Door Controls Mushroom Exit Button 446U Series x 630 on roof side wall adjacent to door
    - a) Install mushroom exit button on roof side into wall mounted Safety Technology International Waterproof Cover STI-1350 x Custom Warning Label
- e. Access Control
  - 1) Card Reader/Intercom to be installed on stair side
    - a) Replace existing card reader with Lenel reader 2 N Intercom with Camera
  - 2) Fire alarm interface on Lenel Panel
    - a) Verify existing to remain or install new interface
    - b) Network drop to roof stair terminal can
    - c) Add new rated backboard and power supply
    - d) Run network cable, outside push button conduit and provide pathway for fire alarm tie in
    - e) Install jack in 6x6 terminal can near door with the sounder mounted to it
    - f) Field verify existing door position switch is intact and operational
- f. Signage and Operational Intent
  - 1) Roof side illuminated EXIT sign
  - 2) Stair side signage and Operational Intent
    - a) Door locked when powered
    - b) Not an exit
    - c) Door will unlock upon emergency door release, fire alarm or loss of power
    - d) Proper credential will unlock momentarily and rearm
    - e) Two-Way communication and remote release
  - 3) Roof side signage and Operational Intent
    - a) Door locked when powered
    - b) Depressing lever handle will activate switch which momentarily deactivates power to magnetic lock for egress into building
    - c) Emergency wall mounted mushroom button will also momentarily deactivate power to magnetic lock if lever handle switch is not successful
    - d) Door will unlock upon fire alarm or loss of power

I. Pedestrian Gates

- a. Welded Gate Boxes:

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- 1) Exit Device – Keedex K-BXED-V992L-2, or approved equal.
  - 2) Corbin/Yale Mortise Lock – Keedex K-BXMOR2, or approved equal.
  - 3) Schlage AD/ Corbin-Russwin IN120 Mortise Lock – Keedex K-BXMOR8155, or approved equal.
- b. Exit Device Plates:
- 1) Adjustable Mounting Plate - DAC Industries 6500-B-24"-Basic, or approved equal.
  - 2) Latch Protector – DAC Industries 6015, or approved equal.
  - 3) Push Pad Protector – DAC Industries 6017, or approved equal gate shield per drawings.
- c. Gate Pivots and Closer (Only where no frame head exists):
- 1) D&D Technologies SureClose
  - 2) Locinox Mammoth-180/ Mammoth-HD
- d. Power Transfer (No flexible door loops allowed):
- 1) Security Door Controls (Model PT-5) for maximum 105-degree swing.
  - 2) Adams Rite (Model 4612-1 for up to 105-degree swing)
    - a) Adams Rite Model 4612-2 for 180-degree swing.

## 1.7 QUALITY ASSURANCE

- A. Supplier Qualifications: An employer of workers trained and only as listed in University Approved Door Hardware Distributors/Installers under Basis-of-Design (BOD).
1. Supplier's responsibilities include supplying and installing door hardware, and providing a qualified Consultant per Part 1.7.B available during the course of the Work to consult with Contractor, Architect, and University about door hardware and keying.
  2. Supplier shall have warehousing facilities in Project's vicinity.
  3. Scheduling Responsibility: Preparation of door hardware and keying schedules.
  4. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. University Approved Door Hardware Distributor/Installer Qualifications: Employ a company who has in their employment person(s) that are currently certified by DHI (Door & Hardware Institute) as an Architectural Hardware Consultant (AHC), Door + Hardware Technician (DHT), Door + Hardware Consultant (DHC), Door + Hardware Specification Consultant (DHSC), Certified Fire & Egress Door Assembly Inspection (CFDAI) or Architectural Openings Consultant (AOC), and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
1. Electrified Door Hardware Consultant Qualifications: A qualified Electrified Hardware Consultant (EHC), Access Control System Consultant (ACSC) or Architectural Openings Consultant (AOC) who is experienced in providing consulting services for electrified door hardware installations.
- C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C Positive Pressure.

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1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches (1016 mm) or less above the sill.
  - D. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
  - E. Pre-Installation Conferences:
    1. Mechanical hardware: Arrange conference at job site to coordinate door, frame, hardware and electronic security hardware installation; to be attended by the Architect, Owner, Contractor and representative personnel of firms involved in the provision and installation of said items.
    2. Electrified hardware: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to electrified door hardware including, but not limited to, the following:
      - a. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.
      - b. Review sequence of operation for each type of electrified door hardware.
      - c. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
      - d. Review required testing, inspecting, and certifying procedures.
  - F. Keying Conference: Conduct conference at Project site after receipt of approved submittals and a minimum of three months prior to Temporary Certificate of Occupancy (TCO) to comply with requirements in Division 01 Section "Project Management and Coordination." Conference participants
  - G. shall include General Contractor, Architect, University Project Manager, University Lock Shop, and General Contractor's door hardware supplier. The University Project Manager will determine additional participants from appropriate department(s). Incorporate keying conference decisions into final keying matrix after reviewing door hardware keying system including, but not limited to, the following:
    1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
    2. Requirements for key control system.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
  - B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.

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- C. Deliver keys and permanent cores directly from manufacturer to University (Facilities Lock Shop Supervisor) by registered mail or overnight package service, with signature required.

#### 1.9 COORDINATION

- A. Coordinate layout and installation of recessed pivots and concealed floor-closers with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices an access control system.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fails in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including excessive deflection, cracking, or breakage.
    - b. Faulty operation of operators and door hardware.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
  - 2. Warranty Period: Two years from date of Substantial Completion, except as follows:
    - a. Continuous Hinges: Five years from date of Substantial Completion.
    - b. Cylindrical Lever Locksets: Five years from date of Substantial Completion.
    - c. Mortise Lever Locksets: Five years from date of Substantial Completion.
    - d. Exit Devices: Three years from date of Substantial Completion.
    - e. Manual Closers: Ten years from date of Substantial Completion.
    - f. Electrified Hardware: Two years from date of Substantial Completion.

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## 1.11 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for University's continued adjustment, maintenance, and removal and replacement of door hardware.

## PART 2 - PRODUCTS

### 2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this Section and door hardware sets indicated in Part 3 "Door Hardware Sets" Article.
  - 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated.
  - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Sets" Article. Products are identified by descriptive titles corresponding to requirements specified in Part 2.
- C. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
  - 2. Alternate Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include manufacturers specified.
- D. Product Substitutions: Provide products as specified. The University shall be the sole judge of whether or not a submitted substitution is deemed to be "equivalent" and accepted.
- E. Fire Rated Doors: Coordinate security hardware equipment and installation so as to maintain the Fire Rating of each specific door to the satisfaction of the local Authority Having Jurisdiction.

### 2.2 HINGES, GENERAL

- A. Quantity: Provide the following, unless otherwise indicated:
  - 1. Two Hinges: For doors with heights up to 60 inches (1524 mm).
  - 2. Three Hinges: For doors with heights 61 to 90 inches (1549 to 2286 mm).
  - 3. Four Hinges: For doors with heights 91 to 120 inches (2311 to 3048 mm).
  - 4. For doors with heights more than 120 inches (3048 mm), provide 4 hinges, plus 1 hinge for every 30 inches (750 mm) of door height greater than 120 inches (3048 mm).

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- B. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
- C. Hinge Size: Provide the following, unless otherwise indicated:
  - 1. Doors up to three foot wide: Standard weight 4 ½ x 4 ½ inches.
  - 2. Doors three foot six inch wide: Heavy-weight 4 ½ x 4 ½ inches.
  - 3. Doors greater than three foot six inch wide: Heavy-weight 5 x 4 ½ inches.
- D. Hinge Type and Weight: Unless otherwise indicated, provide the following:
  - 1. Entrance Doors, Exterior Doors, Doors with Panic Exit Devices, High-Use, High-Abuse and doors with Automatic Operators: Heavy-duty Continuous Hinges unless specified otherwise.
  - 2. Interior Doors: Standard-weight hinges or heavy-weight hinges as required by door size.
  - 3. Doors with Closers: Antifriction concealed bearing hinges.
  - 4. Furnish heavy-weight concealed ball bearing hinges where specified.
  - 5. Incombustible Mineral Core Doors: Continuous hinges or heavy-weight concealed ball bearing hinges.
- E. Hinge Base Metal: Unless otherwise indicated, provide the following:
  - 1. Exterior Hinges: Stainless steel, with stainless-steel pin.
  - 2. Interior Hinges: Steel, or stainless steel, as scheduled.
  - 3. Hinges for Fire-Rated Assemblies: Steel, with steel pin.
- F. Anti-friction Concealed-Bearing, Full-Mortise (Butt) Hinges: BHMA A156.1, heavy weight; Grade 1, with concealed ball bearings, standard weight with concealed ball bearings; button tips; non-rising removable pins.
- G. Hinge Options: Where indicated in door hardware sets or on Drawings:
  - 1. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for reverse-bevel exterior doors.
  - 2. Corners: Square.
- H. Fasteners: Comply with the following:
  - 1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
  - 2. Wood Screws: For wood doors and frames.
  - 3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
  - 4. Screws: Phillips flat-head; machine screws drilled and tapped holes for metal doors wood screws for wood doors and frames. Finish screw heads to match surface of hinges.

## 2.3 HINGES

- A. Butts and Hinges: Certified Grade 1 BHMA A156.1 and listed under Category A in BHMA's "Certified Product Directory."



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B. Template Hinge Dimensions: BHMA A156.7.

C. Manufacturers:

1. Specified: Hager Companies 3-Knucle
2. Alternate: Bommer, McKinney, PBB, Stanley.

## 2.4 NOT USED

## 2.5 CONTINUOUS HINGES

A. Standard: Certified BHMA A156.26 Grade 1-300.

1. Continuous Hinges: Listed under Category N in BHMA's "Certified Product Directory."

B. Continuous, Gear-Type Hinges: Extruded 6063-T6 aluminum alloy, pin-less. Continuous hinges for fire rated doors shall be UL10C listed for type of assembly, without restrictions for wall type and not requiring fire pins up to and including 90 minute rating.

1. Manufacturers:

- a. Specified: National Guard Products.
- b. Alternate: Hager/Roton, Ives, Pemko, Select, Zero.

D. Continuous Pin and Barrel-Type Hinges: Stainless steel hinge leafs with knuckles formed around a stainless steel pin that extends entire length of hinge. Furnish with Hospital Tips (HT) Medical Bearings (MB option). Continuous hinges for fire rated doors shall be UL10C listed for type of assembly, without restrictions for wall type and not requiring fire pins up to an including 3-Hour rating. Continuous metal shims shall be furnished by hinge manufacturer.

1. Manufacturers:

- a. Specified: National Guard Products.
- b. Alternate: Hager, Markar, PBB, Pemko, , Select.

## 2.6 ELECTRIFIED HINGES AND POWER TRANSFERS

A. Electrified Hinges: Schedule at interior low-frequency doors which require electrified door hardware. Comply with the following:

1. Power Transfer: Concealed flexible connector high-temperature Teflon 19-strand wires, secured at each leaf, with centered access holes.
2. Wire leads: Furnish with 4 foot leads, or length of the wire chase plus one foot, whichever is greater.
3. Manufacturers:
  - a. Specified: Hager Companies

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- b. Alternate: Bommer, Command Access, McKinney, PBB, Stanley
- B. Electrified Continuous Hinges: Schedule at exterior doors, doors with panic exit hardware and automatic power operated doors equipped with continuous hinges. Comply with the following:
- 1. Power Transfer: Provide cutout to accommodate Command Access Power Transfer.
    - a. Part #72425: CATEPT4WH\_ALUM\_CON X 24" Leads & 12" CON Pigtails on both sides (Command Access EPT)
    - b. Part #72426: CATEPT4WH\_DURO\_CON X 24" Leads & 12" CON Pigtails on both sides (Command Access EPT)
    - c. Part #72427: CATEPT10WH\_ALUM\_CON X 24" Leads & 12" CON Pigtails on both sides (Command Access EPT)
    - d. Part #72428: CATEPT10WH\_DURO\_CON X 24" Leads & 12" CON Pigtails on both sides (Command Access EPT)
    - e. Part #72429M: CATEPT4WH\_CON X 24" Leads & 12" CON Pigtails on both sides (Modification of customer's VD EPT)
    - f. Part #72430M: CATEPT10WH\_CON X 24" Leads & 12" CON Pigtails on both sides (Modification of customer's VD EPT)
  - 2. Manufacturers:
    - a. Specified: National Guard Products.
    - b. Alternate: Hager, Ives, Markar, National Guard Products, PBB, Pemko, Select.
- C. Power Transfers: Schedule at exit doors, high-traffic doors, and all doors with electrified exit devices. Comply with the following:
- 1. Electrical power transfer in all-metal housing, as scheduled, completely concealed when door is closed, suited for abusive installations, UL10C listed model, designed to accommodate degree of swing.
    - a. Transfer shall be tested to minimum 1,000,000 cycles.
    - b. Wire leads: In-rush current rating minimum designed to meet required maximum amperage surge. Provide transfer with two 18 AWG wires and eight 22 AWG wires.
  - 2. All continuous hinges shall have electrical power transfers preparation performed by the manufacturer. Field modifying continuous hinges for electrical power transfers shall not be allowed.
  - 3. Manufacturers:
    - a. Specified: Command Access Power Transfer.
    - b. Alternate: None.
      - 1) For narrow jamb or stile applications only, or where above power transfers not applicable:
        - a) Specified: Security Door Controls (Model PT-5) for maximum 105-degree swing.
        - b) Alternate: Adams Rite (Model 4612-1) for maximum 105-degree swing.
        - c) Use Adams Rite Model 4612-SC for 90-degree maximum swing-clear
        - d) Use Adams Rite Model 4612-2 for 180-degree swing.

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## 2.7 ELECTRIC STRIKES

- A. Electric strikes shall meet ANSI/BHMA A156.31 Grade 1 requirements, and be listed and labeled under UL 1034 Burglary Resistant Electric Locking Equipment.
- B. Electric strikes for fire rated openings shall be listed and labeled for such use by a testing agency acceptable to authorities having jurisdiction. Fail Secure (fail locked) strikes shall be used at all fire rated openings.
- C. Only acceptable at interior restrooms with automatic operators not connected to Lenel.
  - 1. Manufacturers:
    - a. Specified: HES 8300/8500 Series.
    - b. Alternate: None.

## 2.8 LOCKS AND LATCHES, GENERAL

- A. Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" ANSI A117.1.
  - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).
- B. Latches and Locks for Means of Egress Doors: Comply with CBC 1010.1.9, 11A, 11B. Latches shall not require more than 15 lbf (67 N) to release the latch. Locks shall be readily operable from the inside and not require use of a key, tool, or special knowledge for free egress operation.
- C. Electrified Locking Devices: Comply with BHMA A156.25 and CBC 1010.1.9.7, 1010.1.9.8, 1010.1.9.9, 1010.1.9.12 for products as scheduled.
- D. Lock Trim:
  - 1. Levers: Accessible design as scheduled, through-bolted, cast or solid bar wrought lever trim.
    - a. Yale 8800FL CRR is University Standard for HSC Campus.
  - 2. Roses: Wrought, with concealed fasteners.
  - 3. Dummy Trim: Match lever lock trim and escutcheons.
  - 4. Occupancy Indicators: Furnish mortise lock with indicator "IND" option which indicates "occupied" / "vacant" at privacy units scheduled for single occupant toilet rooms.
- E. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
  - 1. Mortise Locks: Stainless steel anti-friction, minimum 3/4-inch (19-mm) latch-bolt throw.
  - 2. Deadbolts: One-piece Stainless steel, minimum 1-inch (25-mm) bolt throw.
    - a. Only used when furnished as integral with mortise lock with simultaneous retraction.

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- F. Backset: 2-3/4 inches (70 mm), unless otherwise indicated.
- G. Strikes: Manufacturer's standard strike with wrought steel strike box for each latch bolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:
  - 1. Strikes for Mortise Locks and Latches pairs doors: ANSI straight 7/8 inch lip to center.
  - 2. Strikes for Mortise Locks and Latches single doors: ANSI curved lip for mortise locks and latches, with lip length as required for proper clearance with frame trim. Straight lip strikes are not acceptable for single doors.
  - 3. Strikes for Auxiliary Deadlocks: BHMA A156.5.
  - 4. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
- H. Finishes
  - 1. Default finishes shall be BHMA 626 (Satin Chrome) on Yale 5400LN cylindrical locksets or BHMA 630 (Satin Stainless Steel on Yale 8800 or Corbin-Russwin ML2000 mortise locksets.
  - 2. Alternate: Corbin-Russwin 613E/Yale 613e where required to have dark bronze finish to match building standards.

## 2.9 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:
  - 1. Cylindrical Locks: BHMA A156.
  - 2. Mortise Locks: BHMA A156.13.
- B. Cylindrical Lever Locks: BHMA A156.2, Certified Grade 1; Series 4000. Yale RAU5400LN, heavy-duty Cylindrical Locks with free-wheeling lever when locked and prepared to accept interchangeable core master keyed to University System. Verify model number of interchangeable core prep to be used at each project with University Lock Shop. Use M-AU5400LN when Medeco cores are used. Note: Bored locksets should be used generally **for Campus remodel construction or existing retrofit only** and are not intended for new construction or for corridor applications. Verify with University Lock Shop prior to scheduling.
  - 1. Manufacturers:
    - a. Specified: Yale Commercial Locks and Hardware; an ASSA ABLOY Group company.
    - b. Alternate: Schlage, an Allegion company, for electrified only.
  - 2. Cylindrical Lock Typical Functions:
    - a. Passage: 5401LN
    - b. Office: 5407LN
    - c. Classroom: 5408LN
    - d. Storeroom: 5405LN
    - e. Restroom: 5402LN
  - 3. Electrified Cylindrical Lock:
    - a. Schlage ND96EU-RX Rhodes 626, Corbin-Russwin 6pin-LFIC

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- C. Mortise Lever Locks: Campus Standard locks, stamped chrome plated steel case with heavy gauge steel or brass parts; BHMA Grade 1 Heavy-duty, Yale Series 8800FL, with quick reversible latch bolt, which allows unit to be re-handed, without disassembling case.
1. Manufacturers:
    - a. Specified: Yale Commercial Locks and Hardware; ASSA ABLOY Group Co.
    - b. Corbin-Russwin Mortise Locks only at electrified openings.
  2. Certifications:
    - a. BHMA A156.13, Certified Grade 1 Operational and Security.
    - b. UL10C Positive Pressure Fire Listed for up to and including three hour label.
  3. Mortise Lock Typical Functions:
    - a. Passage Latchset: 8801FL
    - b. Suite Entry: 8847FL
    - c. Offices: 8807FL
    - d. Classroom: 8808FL
    - e. Storeroom: 8805FL
    - f. Restroom:
      - 1) Single Occupant: 8802FL V21 EMB
      - a) Lactation: 8840FL V21 EMB
      - 2) Multi-Occupant: 8801FL
      - a) Alternate Hands Free Paddle Latchset: Corbin-Russwin ML2010 HPSK Engraved
    - g. Student housing room entry: 8847FL
    - h. Electrified Mortise Locksets Corbin-Russwin ML20900 ECL Series LWA

## 2.10 AUXILIARY LOCKS AND LATCHES

- A. Auxiliary Locks: BHMA A156.5, Grade 1 unless Grade 2 is indicated. Listed under Category E in BHMA's "Certified Product Directory."
1. Narrow Stile Auxiliary Locks: Not allowed unless approved by USC Lock Shop Supervisor.
  2. Sliding Door Auxiliary Locks:
    - a. Material: Stainless Steel/Brass/Bronze.
    - b. Deadlocks for Sliding Doors: Expanding- or interlocking-type deadbolt operated by key outside and ADA lever thumb-turn inside.
      - 1) Specified: Trimco 1074-2USC-T01-M1074053034.630 Munich x special cam (TRI)
      - 2) Alternate: Inox PD9550 XGT202 Munich x less cylinder (INO).
      - 3) Barn doors require Inox WS-90 or Trimco WS-1074 Series Wall Strike.

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## 2.11 ACCESS CONTROL LOCKS AND TRIM

- A. Access Control Locks: Verify Manufacturer of Access Control Locks with University Lock Shop prior to specifying. ANSI BHMA A156.25, Certified Grade 1 for cylindrical and mortise locks, intended for retrofit construction. Access control locks specified under this Division to be purchased under Division 28.
1. Manufacturers:
    - a. Specified: Schlage/Allegion.
    - b. Alternate: Corbin-Russwin/ASSA ABLOY IN120.
  2. Models used:
    - a. Interior New Construction or Retrofit, in buildings without Lenel: AD400 Series. Use of AD400 must be approved by Lockshop.
      - 1) Mortise Lock: Schlage/Allegion AD400-MS-70-MTK-TLR-JDCO6-4B
        - a) Corbin-Russwin/ASSA ABLOY: IN120-ML20234-BIPS-BIKPS-LWA-CT6D-M17-M34-SA114
      - 2) Cylindrical Lock: Schlage/Allegion AD400-CY-70-MTK-TLR-JDCO6-4B
        - a) Corbin-Russwin/ASSA ABLOY: IN120-CL33134-BIPS-BIKPS-NZD-CT6D-M17-SC114
      - 3) Exit Device Trim: Schlage/Allegion AD400-993R-70-MTK-TLR-JDCO0-4B x 050281 REX kit.
        - a) Corbin-Russwin/ASSA ABLOY Exit Device Trim: IN120-CREK1-231-L-BIPS-BIKPS
        - b) Single Wood Doors: Supported
        - c) Pairs of Wood Doors: Not Supported
        - d) Hollow Metal Single and Pairs: Supported
    - b. Interior New Construction or Interior Retrofit, offline: AD200 Series – Not Allowed.
    - c. All types of Schlage/Allegion models to receive four battery (4B) option.
      - 1) Corbin-Russwin IN locksets use 6 AA Non Proprietary batteries.
- B. Access control lever trim shall match standard mechanical lockset and exit device lever trim.
- C. Units will accept current facility Proximity or Magnetic Stripe card formats. Verify card format with University Lock Shop. Corbin-Russwin/ASSA ABLOY will not support Magnetic Stripe card formats.
1. Lockset Configuration: Lever lock or trim, prepared to accept facility Corbin Russwin interchangeable core.
  2. Provide key override capability by means of Corbin-Russwin Interchangeable Core cylinder. Keying shall be performed by University Lockshop.
  3. Panel Interface Modules (PIM)
    - a. When online AD400 series locks or trim are required furnish Panel Interface Module (PIM400-1501), furnished and installed under Division 28.

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- b. The AD-400 will connect to Lenel via PIM400-1501 without the need to connect to a panel. The AD400-1501 connects directly to network, and has its own panel integration into unit.
- c. No panels or PIMS required with Corbin-Russwin/ASSA ABLOY IN120/IN220 Series Locksets.

## 2.12 ELECTRIFIED LOCKS AND LATCHES

A. Mortise Locks: Campus Standard locks, stamped chrome plated steel case with heavy gauge steel or brass parts; BHMA Grade 1 Heavy-duty, Command Access ML05 series, with quick reversible latch bolt, which allows unit to be re-handed, without disassembling case. Lock shall be fail secure (EU) mode, with request-to-exit (REX) monitor, except at interior stair exit doors which shall have fail-safe (EL) operation. Do not schedule fail-safe electrified trim at exterior perimeter doors. Lever trim design shall be LWA.

- 1. Manufacturers:
  - a. Specified: Command Access (CAT) ML05-EU/EL-REX-LWA.
  - b. Alternate: Corbin-Russwin (COR) ML20906 ECL Series-SEC/SAF-M92-LWA.
    - 1) Command Access LPM190 shall be used where electrified latch retraction mortise locks are required.
- 2. Certifications:
  - a. BHMA A156.13, Certified Grade 1 Operational.
  - b. UL10C Positive Pressure Fire Listed for up to and including three hour label.
- 3. Provide 24 VDC version.

B. Electric Latch Controlled Mortise Locks: Motor operated, low voltage current draw, to retract latch for smooth, quiet retraction, self-contained in exit device rail, UL Listed; with 24 volt DC operation. Command Access LPM1 Series. Include patented PM300 interface power module, designed to allow centralized power supplies, with extended wire runs up to 700 feet, using 18/2 wire. Centralized power supplies furnished and installed by Division 28. Furnish with integral Request to Exit (REX) switch. Comply with the following:

- 1. Manufacturers:
  - a. Specified: Command Access Technology (CAT).
  - b. Alternate: Security Door Controls Z7700 Series (SDC).

## 2.13 DOOR BOLTS, GENERAL

- A. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
- 1. Fire-Rated Surface Bolts: Minimum 1-inch (25-mm) throw; listed and labeled for fire-rated doors.
  - 2. Mortise Flush Bolts: Minimum 3/4-inch (19-mm) throw.

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- B. Dustproof Strikes: BHMA A156.16, Grade 1.
  - 1. Floor Type: Polished wrought brass, with 3/4-inch- (19-mm-) diameter, spring-tension plunger.
- C. Manual Flush Bolts: BHMA A156.16, Grade 1; designed for mortising into door edge. Fabricate from extruded brass or bronze, with 12-inch (305-mm) rod actuated by flat lever. Provide matching strike and equip with top rod extension.
- D. Slide Flush Bolts: Cast brass, with rod actuated by slide. Provide matching strike.

#### 2.14 AUTOMATIC DOOR BOLTS

- A. Automatic Flush Bolts: Fabricated from steel and brass components, with spring-activated bolts that automatically retract when active leaf is opened and that automatically engage when active door depresses bolt trigger; listed and labeled for fire-rated doors. Provide brass or stainless-steel cover plate, top and bottom strikes, guides, guide supports, wear plates, and shims. Furnish two-piece, low-closing force designed units at inactive wood doors to maintain core material integrity and reduce potential delimitation. Top and Bottom bolts required; no less bottom bolt or bottom fire pins will be accepted.
  - 1. Furnish two-piece, low-closing force designed units at inactive wood doors to maintain core material integrity and reduce potential delimitation.
- B. Self-Latching Flush Bolts: Fabricated from steel and brass components, with spring-activated bolts that automatically engage when active door depresses trigger; listed and labeled for fire-rated doors. Bolts are manually retracted by a slide in the bolt face. Provide brass or stainless-steel cover plate, top and bottom strikes, guides, guide supports, wear plates, and shims. Top and Bottom bolts required; no less bottom bolt or bottom fire pins will be accepted.
- C. Dustproof Strikes:
  - 1. Floor Type: Polished wrought brass, with 3/4-inch- (19-mm-) diameter, spring-tension plunger.
- D. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1; designed for mortising into door edge.
  - 1. Manufacturers:
    - a. Specified: Door Controls International.
      - 1) Wood Doors: Model 962.
      - 2) Metal Doors: Models 842/845.
    - b. Alternate: Rockwood; an ASSA ABLOY Company; Ives, an Allegion company; Trimco, Triangle Brass Manufacturing Company.

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## 2.15 EXIT DEVICES, GENERAL

- A. Exit Devices: BHMA A156.3, Grade 1. Listed under Category G in BHMA's "Certified Product Directory", independent lab tested 1,000,000 cycles, with push-through touch pad design.
  - 1. Full compliance to UL 305 Standard for Safety: Panic Hardware.
    - a. Section 4.3: The ends of the crossbar or push pad shall be curved, guarded, or otherwise designed to prevent catching of clothing of persons during exit (Von Duprin PA).
- B. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities ADAAG" and ANSI A117.1. Comply with California Building Code Title 24.
  - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).
- C. Exit Devices for Means of Egress Doors: Comply with CBC 1010.1.10. Exit devices shall not require more than 15 lbf (67 N) to release the latch. Exit devices shall not require the use of a key, tool, or special knowledge for egress operation.
  - 1. All electrical rooms to receive exit devices regardless of rating, amperage or room size.
- D. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
  - 1. Furnish non-fire rated devices without dogging feature.
  - 2. Furnish Cylinder Dogging where required.
- E. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.
- F. Removable Mullions: Provide at specified locations as directed by University, removable mullions for use with exit devices complying with UL (and NFPA80 where labeled) tested and listed by inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions shall be used only with exit devices for which they have been tested. Removable with single turn of building key and securely installed with stabilizer brackets.
- G. Outside Trim: Lever with cylinder, Pull with cylinder; material, finish and design to complement lever trim of locksets, unless otherwise indicated.
  - 1. Lever Trim: Break-away type model 996L x 03, unless otherwise indicated.

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H. Through-Bolts: For exit devices and trim on fire-rated wood doors.

I. Manufacturers:

1. Manufacturers:

a. Specified: Von Duprin; an Allegion Company.

1) PA98 Series at wide stiles.

b. Alternate: None.

G. Finishes

1. Default finishes shall be BHMA 626 (Satin Dull Chrome) or BHMA 630 (Satin Stainless Steel).

2. Alternate: Von Duprin 643e where required to have dark bronze finish to match building standards.

## 2.16 EXIT DEVICES

A. Rim Exit Devices:

1. Type: BHMA A156.3, Type 1, rim; Type 4, narrow stile.

2. Actuating Bar: Push pad.

3. Material: Aluminum/Brass/Bronze, as scheduled.

4. No traditional crossbar Von Duprin 55/88 Series, or other similar devices will be allowed unless prior approval of University Lock Shop Supervisor.

B. Concealed Vertical-Rod Exit Devices:

1. Type: BHMA A156.3, Type 6, narrow stile, Type 8, for metal doors.

2. Type: BHMA A156.3, Type 7, for wood doors.

3. Actuating Bar: Push pad.

4. Material: Aluminum/Brass/Bronze, as scheduled.

5. Configuration: Top and bottom rod. Use less bottom rod (LBR) option on interior doors. No cable devices will be allowed.

6. Furnish all concealed vertical rod (CVR) devices with two top and bottom latch mounting brackets (Model #109324 + screws).

7. All fire-rated and non-rated concealed vertical rod (CVR) devices with bottom rods to receive Von Duprin 385A floor strikes installed into floor or threshold.

8. No Surface Vertical Rod devices will be allowed unless with prior approval of University Lock Shop Supervisor.

9. No traditional crossbar Von Duprin 55/88 Series, or other similar devices will be allowed unless prior approval of University Lock Shop Supervisor.

10. Rigid, Housed, Perimeter Gasketing not to be cut for installation of rim exit device strikes, closer frame brackets or any other surface applied hardware.

C. Electric Latch Controlled Exit Devices: Motor operated, low voltage current draw, to retract latch for smooth, quiet retraction, self-contained in exit device rail, UL Listed; with 24 volt DC

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operation. Command Access MLRK1-VD. Include patented PM300 interface power module, designed to allow centralized power supplies, with extended wire runs up to 700 feet, using 18/2 wire. Centralized power supplies furnished and installed by Division 28. Furnish with integral Request to Exit (REX-) switch. Comply with the following:

1. Manufacturers:
  - a. Specified: Command Access Technology CAT).
  - b. Alternate: None.
  
- D. Electric Controlled Exit Device Trim: Solenoid 24VDCoperated with full wave rectification, self-contained in inside lever escutcheon. Furnish fail-safe design at interior Stair exit doors. Furnish Electrified Lever Trim with Request to Exit (REX-Option) switch integral with exit device and key cylinder. Comply with the following:
  1. Manufact
  2. urers:
    - a. Specified: Von Duprin M996L x REX.
    - b. Alternate: Command Access Technology ET25-R/V-REX x CRU3.
  
- E. Electric Strikes with Automatic Operators are allowed on interior doors only without Lenel.
  1. Manufacturers:
    - a. Specified: HES
    - b. Alternate: Approved equal

## 2.17 LOCK CYLINDERS

- A. Interchangeable Core Lock Cylinder Housings: BHMA A156.5, Grade 1.
  
- B. Cylinders: Interchangeable core, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
  1. Accepts Six-Pin Large Format Interchangeable Core.
  2. Mortise Type: Threaded cylinders with rings and appropriate type cam to properly operate locking device.
  3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
  4. Security Collars: Equip Cylinders on exterior doors with Security Collar to prevent wrenching and rotating of cylinder.
    - a. Manufacturers:
      - 1) Specified: Corbin-Russwin 416F39.
      - 2) Alternate: None.
  
- C. Other Cylinder Housing and Core Requirements:
  1. Medeco buildings to receive Medeco Large Format Interchangeable Core on interior.
  2. All electrical rooms, mechanical spaces and ITS rooms to receive Medeco Large Format Interchangeable Electronic eKey cylinders.
  3. ASSA buildings to receive ASSA Large Format Interchangeable Cores.
  4. All Lenel controlled doors to receive Corbin-Russwin Large Format Interchangable Cores.
  
- D. Permanent Cores: Furnished and installed by University Lock Shop.

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- E. Construction Keying and Cores: Comply with the following:
  - 1. Construction Master Keys: Provide 20 construction master keys.
  - 2. Construction Cores: Provide construction cores that are replaceable by permanent cores.
  - 3. Material: Brass. Plastic temporary or disposal cores will not be acceptable.
  - 4. University Lock Shop will return construction cores to General Contractor upon installation of permanent cores.
- F. Cylinder position on door or device must allow for key insertion and sufficient rotation to unlock from a minimum 4-inch diameter closed ring without interference or restrictions (University Department of Public Service, Lock Shop, FMS, etc.)
- G. Subject to compliance with LAFD Requirement 75, provide emergency entrance key vault(s); Knox Company 4400 Series, or 3200 Series. No Substitution Allowed.
  - 1. Finish Color - Black, Dark Bronze or Aluminum as selected by Architect.
  - 2. Where indicated provide security key override switches for electrically activated openings.
  - 3. Coordinate and provide keying and type per fire/ police department, and other jurisdictional agency requirements.

## 2.18 KEYING

- A. All keying and keys supplied by University Lock Shop.

## 2.19 OPERATING TRIM, GENERAL

- A. Standard: BHMA A156.6 and as illustrated on Drawings.
- B. Materials: Fabricate from stainless steel, bronze, or brass as scheduled.
- C. Manufacturers:
  - 1. Trimco.
  - 2. Ives, an Allegion company.
  - 3. Rockwood; an ASSA ABLOY company.

## 2.20 OPERATING TRIM

- A. Push-Pull Plates: 1/8 inch (3.2 mm) thick, 4 inches wide by 16 inches high (102 mm wide by 406 mm high); with square corners, beveled edges, and raised integral lip; secured with exposed screws.
- B. Straight Door Pulls: 1-1/4-inch (19-mm) constant-diameter full height vertical pull on pull side of door only, with minimum clearance of 1-1/2 inches (38 mm) from face of door. Pull on push side of door must not obstruct bottom 10-inches of door.

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1. Mounting: Surface applied with concealed fasteners or Back to back with threaded sleeves.
2. Straight door pulls mounting coordinating when locking cylinders as used for position on door must allow for key insertion and sufficient rotation to unlock from a minimum 4-inch diameter closed ring without interference or restrictions (University Department of Public Service, Lock Shop, FMS, etc.)
- C. Offset Door Pulls: 3/4-inch (19-mm) constant-diameter pull, with minimum clearance of 1-1/2 inches (38 mm) from face of door and offset of 2 inches (51 mm); fastened at minimum of 10 inches (203 mm) o.c.
  1. Hands Free design as approved by Lockshop.
  2. Mounting: Surface applied with concealed fasteners.
  3. Offset door pulls mounting coordinating when locking cylinders as used for position on door must allow for key insertion and sufficient rotation to unlock from a minimum 4-inch diameter closed ring without interference or restrictions (University Department of Public Service, Lock Shop, FMS, etc.)
- D. Pull-Plate Door Pulls: 1/8 inch thick plate, 4 inches wide by 16 inches high (102 mm wide by 406 mm high), with square corners and beveled edges; 3/4-inch (19-mm) constant-diameter pull, with minimum clearance of 1-1/2 inches (38 mm) from face of door; fastened at 8 inches (203 mm) o.c.
  1. Mounting: Surface applied with concealed fasteners.
- E. Custom Designer Pulls: Special or logo Push or Pull designs must have shop drawings submitted for approval of University Lock Shop Supervisor prior to fabrication.

## 2.21 ACCESSORIES FOR PAIRS OF DOORS

- A. Carry-Open Bars: Provide carry-open bars for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
  1. Material: Satin chrome plated, or dark bronze as scheduled, with strike plate.
- B. Flat Overlapping Astragals: Flat metal bar, surface mounted on face of door with tamper proof screws; minimum 1/8 inch (3.2 mm) thick by 2 inches (50 mm) wide by full height of door; and base metal as follows:
  1. Base Metal: Dark bronze anodized, painted steel, or stainless steel, as scheduled.
- C. Rigid, Housed Meeting Stile Astragals: Gasket material held in place by metal housing; fastened to face of door with screws.
  1. Gasket Material: Nylon brush.

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2. Housing Material: Aluminum, or dark bronze anodized, as scheduled.
  3. Manufacturers:
    - a. Specified: Pemko 29324\_NB.
    - b. Alternate: National Guard, Zero.
- D. Overlapping-with-Gasket Astragals: T-shaped metal, surface mounted on edge of door with screws; with integral gasket and base metal as follows:
1. Base Metal: Aluminum, or dark bronze anodized, as scheduled.
  2. Gasket Material: Silicone.
  3. Manufacturers:
    - a. Specified: Pemko 355\_S.
    - b. Alternate: National Gurad, Zero.
- E. Coordinators: BHMA A156.3.
1. Bar type mounted on frame stop soffit, complete with filler bar and mounting brackets, painted to complement finish of other scheduled door hardware.
  2. Manufacturers:
    - a. Specified: Door Controls International.
    - b. Alternate: IVES Hardware; an Allegion Company, Rockwood; an ASSA ABLOY Company; Trimco.

## 2.22 CLOSERS, GENERAL

- A. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the 2020 Department of Justice "ADA Standards for Accessible Design" and U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and ANSI A117.1. Comply with the following maximum opening-force requirements:
- a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
  - b. Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.
  - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction, not to exceed maximum of 15 pounds.
- B. Hold-Open Closers/Detectors: Coordinate and interface integral smoke detector and closer device with fire alarm system.
- C. Power-Assist Closers: As specified in Division 08 71 13 Section "Automatic Door Operators" for access doors for people with disabilities or where listed in door hardware sets.
- D. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and

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anticipated frequency of use. Provide factory multi-sized closers, adjustable to meet field conditions and requirements for opening force.

- E. Surface Closers: BHMA A156.4, Grade 1. Listed under Category C in BHMA's "Certified Product Directory." Provide type of arm required for closer to be located on non-public side of door, inside rooms, stairs and interior of building.
  - 1. Manufacturers:
    - a. Specified: LCN Closers (model 4040XP/4041DEL); an Allegion Company.
      - 1) Inswinging Doors with closer mounted on pull side:
        - a) Furnish 4040XP/4041DEL to 120-degrees.
        - b) Furnish TJ4040XP-T x 4040T-18TJ at 180-degrees.
      - 2) Outswing doors with closer mounted on push side:
        - a) Furnish 4040XP-EDA
      - 3) Smaller width leaf of unequal pairs:
        - a) Furnish LCN 4031 Series (Use ST-3507 for inswinging door).
    - b. Alternate: None
  - 2. Student housing rooms only: Norton Door Controls (model 1601/1601BF Series); an ASSA ABLOY Group Company.
- F. Overhead Concealed Closers: Not allowed unless approved by USC Lock Shop Supervisor.
- G. Floor Concealed Closers: Not allowed unless approved by USC Lock Shop Supervisor.
- H. Closer Holder Release Devices: BHMA A156.15. Listed under Category C in BHMA's "Certified Product Directory."
  - 1. Life-Safety Type: On release of hold open, door becomes self-closing. Automatic release is activated by smoke detection system.
  - 2. Manufacturers:
    - a. Specified: LCN Closers; an Allegion Company.
    - b. Alternate: None.

## 2.23 CLOSERS

- A. Modern-Type-with-Cover Surface Closers: Non-handed, rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; with forged-steel main arm; enclosed in cover indicated; complying with the following:
  - 1. Mounting: Hinge side or Parallel arm, type as scheduled.
  - 2. Type: Delayed action closing, where scheduled.
  - 3. Back-check: Adjustable, effective between 60 and 85 degrees of door opening.
  - 4. Closing Power Adjustment: Fully-adjustable with at least 50 percent more than minimum tested value.
  - 5. Cover Material: Molded plastic Aluminum Painted or Plated steel, as scheduled.
  - 6. Arm Options: Furnish regular or parallel arm units as required to mount closer inside rooms or stairs.

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7. Stop Arm Options: Furnish with separate concealed or surface mounted overhead stop where required to limit swing of door due to obstruction or where use of conventional wall or floor stop is prohibited.
8. Mounting Plates: Provide closer with drop and full decorative back plates, as required to properly mount unit to door and frame installation.
9. Rigid, Housed, Perimeter Gasketing not to be cut for installation of rim exit device strikes, closer frame brackets or any other surface applied hardware.

#### 2.24 PROTECTIVE TRIM UNITS, GENERAL

- A. Size: 2 inches (38 mm) less than door width on push side and 1 inch (13 mm) less than door width on pull side, by height specified in door hardware sets.
- B. Countersunk Fasteners: Manufacturer's standard machine or self-tapping screws.
- C. Metal Protective Trim Units: Furnish at reverse bevel doors in corridors and exterior doors, beveled on four sides; fabricated from the following material:
  1. Material: 0.050-inch- (1.3-mm-) thick stainless steel or bronze, type as scheduled.
  2. Manufacturers:
    - a. IVES Hardware; an Allegion Company.
    - b. Rockwood; an ASSA ABLOY Company.
    - c. Trimco.

#### 2.25 PROTECTIVE TRIM UNITS

- A. Armor Plates: 36 inches (914 mm) high by door width, with allowance for frame stops.
  1. Per NFPA-80 protection plates over 16 inches (406 mm) high shall bear a UL Listing.
    - a. Engraved, embossed, or stamped label will be required:
      - 1) Specified: Trimco KA050 Series "ULS".
      - 2) Alternate: Approved equal as listed above.
    - b. No adhesive type mylar or paper labels will be acceptable.
- B. Kick Plates: 10 inches (305 mm) high by door width, with allowance for frame stops.
- C. Mop Plates: 6 inches (152 mm) high by 1 inch (25 mm) less than door width.

#### 2.26 STOPS AND HOLDERS, GENERAL

- A. Stops and Bumpers: BHMA A156.16, Grade 1, unless Grade 2 is indicated.
  1. Provide at exterior doors; heavy-duty base unit 2-1/2 inch by 2-1/4 inch height floor stops with exterior pack three fastener machine screws by expansion anchors, or heavy-duty anti-vandal unit with flame resistant molded rubber two inch diameter by 3-1/2 inch height (Trimco model 1209HA).



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2. Where floor type stop will present a pedestrian hazard furnish heavy-duty overhead concealed stop, or closer with integral stop, type as required.
  3. Furnish Trimco model 7280 floor stops at interior in-swing doors, Trimco model 7281 floor stops at doors with panic or exit devices.
  4. Wall stops not allowed unless approved by USC Lock Shop Supervisor.
  5. Do not mount floor stops where they will impede traffic. Where floor stops are not appropriate, provide overhead stops or holders.
- B. Mechanical Door Holders: BHMA A156.16, Grade 1 unless Grade 2 (Trimco 1260 Series).
- C. Silencers for Wood Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum 5/8 by 3/4 inch (16 by 19 mm); fabricated for drilled-in application to frame.
- D. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch (13 mm); fabricated for drilled-in application to frame. Silencers shall not be used at fire-rated frames.
- E. Manufacturers:
1. Specified: Trimco
  2. Alternate: Ives, an Allegion Company, Rockwood, an ASSA ABLOY Company.
- F. Electromagnetic Door Holders: Coordinate with fire detectors and interface with fire alarm system for labeled fire door assemblies.
1. Listed under Category C in BHMA's "Certified Product Directory."
  2. Manufacturers:
    - a. Specified: Rixson Specialty Door Controls; an ASSA ABLOY Group Company.
    - b. Alternate: LCN, an Allegion Company.

## 2.27 STOPS AND HOLDERS

- A. Wall Bumpers: Not allowed unless approved by USC Lock Shop Supervisor.
- B. Rigid Floor Stops: Cast brass or bronze with rubber bumper; expansion-shield application.
- C. Electromagnetic Door Holders: BHMA A156.15, Grade 1; electromagnet attached to wall or floor as indicated, and strike plate attached to swinging door.
1. Configuration: Wall-mounted single unit.
  2. Options: Provide adjustable length armature extension unit where required due to wall-depth.

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## 2.28 OVERHEAD STOPS AND HOLDERS

- A. Overhead Concealed Slide Holders: BHMA A156.8, Type 1; hold open and release by push and pull of door unless control is set in inactive position; with stop and shock absorber; adjustable holding pressure; for single acting doors opening 110 degrees.
- B. Overhead Concealed Slide Stops: BHMA A156.8, Type 1; release by push and pull of door unless control is set in inactive position; with stop and shock absorber; adjustable holding pressure; for single acting doors opening 110 degrees.
  - 1.
  - 2. Manufacturers:
    - a. Specified: Rixson Specialty Door Controls; an ASSA ABLOY Group Company.
    - b. Alternate: Architectural Builders Hardware (ABH), Glynn-Johnson; an Allegion Company

## 2.29 DOOR GASKETING, GENERAL

- A. Standard: BHMA A156.22. Listed under Category J in BHMA's "Certified Product Directory."
- B. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide non-corrosive fasteners for exterior applications and elsewhere as required for wet locations.
  - 1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
  - 2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
  - 3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.
- C. Air Leakage: Not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.
- D. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.
  - 1. Provide smoke-labeled gasketing on S-labeled doors and at fire-rated doors.
- E. Fire-Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to Standard UL-10C.
  - 1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches (1016 mm) or less above the sill.
- F. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408. Sound seals shall realize a 97% rating as tested under requirements of E90 and BS EN ISO 140-3

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- G. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- H. Gasketing Materials: ASTM D 2000 and AAMA 701/702.
- I. Manufacturers:
  - 1. Specified: Pemko Manufacturing, an ASSA ABLOY Company
  - 2. Alternate: National Guard; Zero, an Allegion Company.

## 2.30 DOOR GASKETING

- A. Adhesive-Backed Perimeter Smoke Gasketing: Gasket material applied to frame rabbet with self-adhesive.
  - 1. Gasket Material: Silicone.
    - a. Specified: Pemko, an ASSA ABLOY Company.
      - 1) Model S88, or S44 as required.
    - b. Alternate: National Guard; Zero, an Allegion Company.
- B. Adhesive-Backed Perimeter Sound Gasketing: Gasket material applied to frame rabbet with self-adhesive.
  - 1. Gasket Material: Silicone.
    - a. Specified: Pemko, an ASSA ABLOY Company, one set model S773.
    - b. Alternate: National Guard; Zero, an Allegion Company.
- C. Rigid, Housed, Perimeter Gasketing: Gasket material held in place by metal housing; fastened to frame stop with screws.
  - 1. Gasket Material: Silicone.
    - a. Specified: Pemko, an ASSA ABLOY Company, model 2891\_S, type as scheduled.
    - b. Alternate: National Guard; Zero, an Allegion Company.
  - 2. Housing Material: Clear anodized aluminum or dark bronze anodized aluminum, type as scheduled.
  - 3. Rigid, Housed, Perimeter Gasketing not to be cut for installation of rim exit device strikes, closer frame brackets or any other surface applied hardware.
- D. Overlapping Astragals for Pair's Doors: Gasket material held in place by metal housing and overlapping when doors are closed; mounted to face of meeting stile with screws.
  - 1. Gasket Material: Silicone bulb.
  - 2. Housing Material: Clear anodized aluminum, dark bronze anodized aluminum or stainless steel, type as scheduled.
  - 3. Mounting: Surface mounted to one door.
- E. Meeting Astragals for Meeting Stiles: Gasket material held in place by metal housing; mounted with screws.

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1. Gasket Material: Nylon brush.
    - a. Specified: Pemko, an ASSA ABLOY Company, model 29324\_NB.
    - b. Alternate: National Guard; Zero, an Allegion Company.
  2. Housing Material: Clear anodized aluminum or dark bronze anodized aluminum, type as scheduled.
  3. Mounting: Surface mounted on face of each door. Miter bottom of astragal and leading edge of door sweep at 45-Degree angle.
- F. Door Sweeps: Gasket material held in place by flat metal housing or flange; surface mounted to face of door with screws, concealed by smooth extruded housing.
1. Gasket Material: Nylon brush.
    - a. Specified: Pemko, an ASSA ABLOY Company, model 293100\_NB.
    - b. Alternate: National Guard; Zero, an Allegion Company.
  2. Housing Material: Clear anodized aluminum or dark bronze anodized aluminum, type as scheduled.
  3. Miter bottom of meeting stile astragals and leading edge of door sweep at 45-Degree angle.
- G. Automatic Door Bottoms: Gasket material held in place by metal housing that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.
1. Gasket Material: Sponge silicone.
  2. Housing Material: Clear anodized aluminum, or dark bronze anodized aluminum, type as scheduled.
  3. Mounting: Mortised into bottom of door, type as scheduled.
  4. Type: Low-closing-force type for doors required to meet accessibility requirements.

## 2.31 THRESHOLDS, GENERAL

- A. Standard: BHMA A156.21. Listed under Category J in BHMA's "Certified Product Directory."
- B. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." ANSI A117.1 and CBC Chapter Eleven Accessibility.
1. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
- C. Manufacturers:
1. Specified: Pemko Manufacturing, an ASSA ABLOY Company
  2. Alternate: National Guard; Zero, an Allegion Company.

## 2.32 THRESHOLDS

- A. Saddle Thresholds: Type and base metal as follows:

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1. Type: Smooth top, Fluted top, type as scheduled.
  2. Base Metal: Aluminum or dark bronze anodized aluminum, type as scheduled.
- B. Half-Saddle / Offset Thresholds: Fluted-top metal member; and base metal of aluminum with beveled slope on one side, not steeper than 1:2 inch slope.
1. Base Metal: Aluminum or dark bronze anodized aluminum, type as scheduled.

#### 2.33 FOLDING AND SLIDING DOOR HARDWARE, GENERAL

- A. General: BHMA A156.14; consisting of complete sets including overhead rails, hangers, supports, bumpers, floor guides, and accessories indicated.
1. Interior Doors: Provide door hardware for interior bi-folding and bi-passing doors when not furnished as part of door package.
- B. Bi-folding and Sliding Door Hardware: Rated for door panels weighing up to 300 lb.
- C. Multiple Folding and Sliding Door Hardware: Rated for door panels weighing up to 600 lb.
- D. Opening force must comply with Accessibility Requirements.
- E. Track assembly must have dampers that slow end of opening/closing cycle to prevent injury.
- F. Track assembly to be side or head installed as required.
- G. Furnish end caps and fascia as required.
- H. Component manufacturers:
1. Specified: KN Crowder Catch'N'Close
  2. Alternate: None.
- I. System assembly manufacturers:
1. Specified: KN Crowder "Crowder Slide"
  2. Alternate: None.

#### 2.34 FOLDING AND SLIDING DOOR HARDWARE

- A. Door Hardware: Rails and door hardware that allow horizontal and vertical adjustment.
1. Rail Material: Galvanized wrought steel or aluminum as specified.
  2. Rail Configuration: I-beam.
  3. Mounting: Surface mounted overhead.
  4. Wheel Assembly: Two wheel or four wheel, with roller bearings.
  5. Wheel Material: Steel or nylon as specified.

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- B. Multiple Door Hardware: Rails and door hardware that allows horizontal and vertical adjustment.
  - 1. Rail Material: Galvanized wrought steel.
  - 2. Rail Configuration: I-beam.
  - 3. Mounting: Surface mounted overhead.
  - 4. Wheel Assembly: Two wheel or four wheel, with roller bearing.
  - 5. Wheel Material: Steel or nylon as specified.

## 2.35 FABRICATION

- A. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.
- B. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
  - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt, painted to match door face.
  - 2. Steel Machine or Wood Screws: For the following fire-rated applications:
    - a. Mortise hinges to doors.
    - b. Strike plates to frames.
    - c. Closers to doors and frames.
  - 3. Steel Through (SNB) Bolts: University generally requires concealed fasteners to be specified, unless Manufacturers' installation requires use of through-bolts. The following fire-rated applications may require use of sex-nut bolts unless door blocking is provided:
    - a. Surface hinges to doors.
    - b. Through-Bolt attachments will not be allowed on door closers. Coordinate with door manufacturers to provide the proper reinforcement or blocking to prevent the use of through-bolts.
    - c. Surface-mounted exit devices.
  - 4. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."

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## 2.36 FINISHES

- A. Standard: BHMA A156.18, finish as selected by project designer and indicated in door hardware sets.
  - 1. Default finishes shall be BHMA 652 (Satin Chrome), BHMA 626 (Satin Chrome) or BHMA 630 (Satin Stainless Steel).
  - 2. Alternate: Where required to match existing building standards for dark bronze finishes furnish BHMA 613e, Von Duprin 643e.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Unless otherwise indicated, finishes shall conform to those identified in ANSI/BHMA A156.18. Comply with base material and finish requirements indicated by the following:
  - 1. BHMA 600: Primed for painting, steel base metal.
  - 2. BHMA 606: Satin brass, clear coated, brass base metal.
  - 3. BHMA 613: Dark-oxidized satin bronze, oil rubbed, bronze base metal.
  - 4. BHMA 626: Satin chromium plated over nickel, brass or bronze base metal.
  - 5. BHMA 627: Satin aluminum, clear coated, aluminum base metal.
  - 6. BHMA 628: Satin aluminum, clear anodized, aluminum base metal.
  - 7. BHMA 630: Satin stainless steel, stainless-steel base metal.
  - 8. BHMA 640: Dark-oxidized satin bronze plated over copper plate, oil rubbed, steel base metal.
  - 9. BHMA 652: Satin chromium plated over nickel, steel base metal.
  - 10. BHMA 682: Satin chromium plated over nickel, zinc base metal.
  - 11. BHMA 689: Aluminum painted, any base material.
  - 12. BHMA 695: Dark bronze painted, any base material.
  - 13. BHMA 710: Dark-oxidized satin bronze anodized, aluminum base metal.
  - 14. BHMA 718: Satin aluminum, uncoated, aluminum base metal.
  - 15. BHMA 719: Mill finish aluminum, uncoated, aluminum base metal.
  - 16. BHMA 722: Dark-oxidized bronze, oil rubbed, architectural bronze base metal.

## PART 3 - EXECUTION

### 3.1 SPECIAL INSTRUCTIONS

- A. Emergency Exiting Requirements
  - 1. Free Egress at Controlled Doors: Electrically controlled doors shall be operable from the secured side without the use of access cards, keypads or requiring any special knowledge. Mechanical Request-To-Exit (REX) switches integral with door hardware shall sense a

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person needing egress and automatically bypass the alarm function. Motion or Passive Infrared Sensors will not be allowed.

- a. Doors equipped with electrified Mortise Locks or Electrified Exit Hardware:
  - 1) The hardware configuration on access controlled doors shall enable egress without requiring electrical release of its associated mortise lock or electrified exit device.
  - 2) Door handles on the egress side shall retract latch bolt from the strike.
  - 3) The access system shall detect the normal egress of a user at any individual portal with a Request To Exit switch built directly into the mechanism used to egress and shall bypass any alarm associated with the portal for an individually programmable duration.
- b. Stairwell Door Locks:
  - 1) Stairwell doors which are locked from the stairwell side shall have the capability to be unlocked simultaneously upon a signal from the Fire Command Center and the Security Command Center.
  - 2) Stairwell locking systems shall comply with the requirements of the applicable Building Code relating to Means of Egress.
  - 3) Contractor shall provide clearly labeled switches in the required locations to unlock all stairwell doors simultaneously. Coordinate wall or desk mounted switch style with the University and the Authority Having Jurisdiction.
  - 4) This interface shall not depend on the EACS Host or Remote Controllers for its operation. Locate interface relays for each stairwell door electrically ahead of EACS lock control to independently override EACS control.
2. Request-To-Exit Activation: Request-To-Exit devices shall always be connected to EACS inputs for processing and control. Independent Request-To-Exit devices shall never be connected directly to electrified locks, local control relays, or power supplies.
3. Mechanical Lock Operation: Electrified locks shall be mechanically keyed to permit manual unlocking in an emergency. Mechanical operation shall not override door monitoring functions.
4. Lock Failure Configuration:
  - a. Electrified Stairwell Locks: Electrified stairwell locks, including panic hardware that is locked in the direction of egress, shall be configured as fail-safe, i.e.: the lock shall lock only when powered. Coordinate the selected hardware with the University to assure its suitability for the purpose intended.

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- b. Other electrified locks: All other electrified locks and exit devices shall be configured as fail-secure, i.e.: the lock or exit device shall unlock only when powered. Coordinate the selected hardware with the University to assure its suitability for the purpose intended.
5. Fire Alarm Interface: Electrified locks and exit hardware which are a part of this work and which are locked in the path of legal exiting shall be connected to the building Fire Alarm System in accordance with University requirements such that they automatically unlock in the event of activation of the Fire Alarm System. This shall occur whether the activation is a result of a manual pull station, smoke detector or sprinkler flow switch.
- a. A fire alarm “general/common alarm relay” shall be programmed at the fire alarm control panel to activate the EACS interface relays located in each Lock Power Supply cabinet. The Contractor shall research and provide all necessary fire alarm system conduit, wire, hardware and programming to perform the required interface.
  - b. This interface shall not depend on the EACS Host or Remote Controllers for its operation. Locate these interface relays electrically ahead of lock power distribution as shown on the drawings. The Contractor shall supply and install programmed alarm interface relay(s) with sufficient capacity to control the power supplied to all controlled locks under Division 28.

### 3.2 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance. Notify Architect of any incompatibilities, prior to commencing affected work.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 Series.
  1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.
- B. Wood Doors: Comply with DHI A115-W Series.

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### 3.4 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.
1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
  2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
  3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
  4. Bottom Hinge: 10 inches from door bottom to bottom of hinge.
  5. Top Hinge: 5 inches from door top to top of hinge.
  6. Center Hinge(s) or Pivot(s): Spaced equidistantly between top and bottom hinges/ pivots.
  7. Lockset / Latchset: 38 inches from finished floor to center of lever.
  8. Hospital Push-Pull Latchset/ Lockset: 42 inches from finished floor to center of latch.
  9. Exit Device: 38 inches from finished floor to device centerline.
  10. Deadlock: Maximum height of 44 inches from finished floor to center key cylinder / thumb turn.
  11. Push Plate/ Pull Plate: 42 inches from finished floor to center of pull.
  12. Floor Stop: Adjacent to wall; not to exceed 4 inches from face of wall; located 3 inches from latch edge of door; in any case never more than 50 percent of door width from latch edge of door.
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
  2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
  3. Set units to allow maximum door swing, unless door encounters obstruction. In such case install hardware to allow minimum 90 degree swing, set to limit from encountering obstruction.
  4. When hardware is to be attached to existing metal surface and insufficient reinforcement exists, use Riv-Nuts, Nut-Serts, or similar anchoring device fasteners.
- C. Door Closers: Install door closers inside rooms, stairs and within building interior, with fasteners that are not exposed on door. Coordinate with Wood Door Division to insure doors are supplied with required top rail blocking reinforcement to enable non-through bolted installation. For special doors where blocking reinforcement construction is not available furnish closer with sex-nut bolt sleeve fasteners, painted to match door face finish.
- D. Power Supplies: Locate power supplies as indicated, in equipment rooms. Verify location with Architect. Furnished and installed by Division 28.
1. Configuration: Provide the least number of power supplies centrally located, required to adequately serve doors with electrified door hardware.

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- E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants." Install thresholds with ¼ - 20 Stainless steel or dark bronze machine screws, type as scheduled and expansion shields.
- F. Floor Stop: Adjacent to wall; not to exceed 4 inches from face of wall; located 3 inches from latch edge of door; in any case never more than 50 percent of door width from latch edge of door.
- G. Rigid, Housed, Perimeter Gasketing not to be cut for installation of rim exit device strikes, closer frame brackets or any other surface applied hardware.

### 3.5 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: Engage a University Basis-of-Design approved Independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
  - 1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted, and prepare a specific list of any deficiencies, a copy of which shall be provided to the Architect.
  - 2. Contractor shall correct all deficiencies noted in above report.
  - 3. Independent Architectural Hardware Consultant shall re-inspect door hardware and prepare a report certifying correction of deficiencies and compliance with requirements.

### 3.6 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
  - 1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
  - 2. Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
  - 3. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, General Contractor shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

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### 3.7 CLEANING AND PROTECTION

- A. Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products.
- B. Clean adjacent surfaces soiled by door hardware installation. Remove construction debris from project site and legally dispose of debris.
- C. Clean installed products in accordance with manufacturer's instructions prior to University's acceptance.
- D. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

### 3.9 FINAL PROCEDURES

- A. Perform final procedures in accordance with
  - 1. Section 28 05 00, Security General Requirements.
- B. Independent Certified Fire and Egress Door Assembly Inspector (CFDAI), certified by the Door & Hardware Institute (DHI) and audited as an Intertek Qualified Personnel (IQP), shall inspect new and existing fire and egress swinging doors with Builders Hardware after any required corrective actions performed in accordance with NFPA-80, NFPA-101, NFPA-105.
  - 1. Issue report in format approved by University to be used for subsequent Annual Fire and Egress door inspection requirements.

### 3.10 DOOR HARDWARE SCHEDULE (SETS)

**(TO BE ENGINEERED FOR SPECIFIC PROJECT BY DHI CERTIFIED AHC AS DESIGNATED)**

END OF SECTION 087102

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# USC DESIGN GUIDELINES

## 09 2400 EXTERIOR CEMENT PLASTER

### 1. OVERVIEW

- A. Purpose: USC exterior cement plaster preferences and requirements are described in this Section.
1. For other related requirements, refer to Section 01 0000 "General Requirements" for exterior wall mockups.
- B. The following table summarizes the types of particular requirements identified within this Section. Requirements listed are intended to provide a flat exterior plaster wall system with moderate resistance to cracking and shrinkage:

Requirements Listed	Preferences Listed	Disallowed Items Listed	Items Requiring Commissioning/ Testing
X	X		

### 2. QUALITY ASSURANCE REQUIREMENTS

- A. System requirements for exterior portland cement plaster wall systems:
1. Required for all projects:
    - a) Metal or wood stud exterior framing system, with framing spaced at a maximum of 16 inches on-center.
    - b) Sheathing as a substrate for plaster systems. Provide gypsum sheathing unless structural OSB or plywood sheathing is required.
      - a) Preference: Exterior fiberglass-faced gypsum sheathing, with taped joints.
    - c) Provide continuous weather barrier over sheathing.
      - a) Preference: Spray-applied vapor-permeable barrier.
    - d) Provide expanded metal lath over sheathing and weather barrier, minimum 3.4 pound weight per square foot of lath.
    - e) Apply 3-coat portland cement plaster system over lath.
  2. Requirements to be determined on a project-by-project basis:
    - a) Finish coat of plaster system may be premixed plaster, acrylic mix, or site mixed plaster finish coat.
    - b) Plaster finish may be integrally colored, field painted, or both.
    - c) Plaster texture to be determined on a project-by-project basis, based on project design or functional requirements.
    - d) Requirements for water-repellent surface sealer, if any, will be evaluated on a project-by-project basis.
- B. Warranty Requirements: Warrant installed plaster system to resist cracking, other than hairline cracks, for 3 years.
1. Hairline cracks are not noticeable or apparent when observed in normal daylight from a distance of 20 feet.

## USC DESIGN GUIDELINES

### 3. PRODUCT REQUIREMENTS

- A. Exterior glass-mat gypsum sheathing complying with ASTM C 1177.
  - 1. Products equivalent to the following:
    - a) CertainTeed Corporation; GlasRoc.
    - b) G-P Gypsum Corporation; Dens-Glass Gold.
    - c) National Gypsum Company; Gold Bond e(2)XP.
    - d) Temple-Inland Inc.; GreenGlass.
    - e) United States Gypsum Co.; Securock.
- B. Synthetic Polymer Weather Barrier Membrane:
  - 1. Products equivalent to the following:
    - a) Carlisle Coatings & Waterproofing Inc.; Barritech VP.
    - b) Grace, W. R., & Co. - Conn.; Perm-A-Barrier VP.
    - c) Henry Company; Air-Bloc 31 or Air-Bloc 33.
- C. Expanded-Metal Lath: ASTM C 847 with ASTM A 653, G60, hot-dip galvanized zinc coating.
  - 1. Self-furring, diamond mesh lath, minimum 3.4 lb/sq. yd.
- D. Fiber for Base Coats: Add fiber to base-coat mixes to minimize cracking and shrinkage.
  - 1. Do not exceed ratio of 1 lb of fiber per cu. yd. of cementitious materials.

### 4. INSTALLATION REQUIREMENTS

- A. Determine optimum curing conditions and methods on a project-by-project basis.
- B. Control Joints:
  - 1. Vertical Surfaces: 144 sq. ft. maximum area of plaster panels between joints.
  - 2. Horizontal and other Nonvertical Surfaces: 100 sq. ft. maximum area of plaster panels between joints.
  - 3. Install at distances between control joints of not greater than 18 feet o.c.
  - 4. Install as required to delineate plasterwork into areas (panels) with length-to-width ratios not greater than 2-1/2:1.
  - 5. Install where control joints occur in surface of construction directly behind plaster.
  - 6. Install where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 10 2113 TOILET COMPARTMENTS AND TOILET ACCESSORIES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements for the following are described in this document:
1. Toilet compartments, configured as toilet enclosures entrance screens and urinal screens.
  2. Public-use washroom (toilet) accessories.
- B. The following table summarizes the types of particular requirements identified within this Section:

Requirements Listed	Preferences Listed	Disallowed Items Listed	Items Requiring Commissioning /Testing
X	X	X	

### 2. PROCEDURAL REQUIREMENTS

- A. Design Considerations:
1. Required: Each building (all USC campuses) must have at least one gender-neutral restroom facility.
- B. Quality Assurance Requirements (Beyond Standard One-Year Warranty):
1. Required: Special mirror warranty.
    - a) Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
    - b) Warranty Period: 15 years from date of Substantial Completion.

### 3. PRODUCT REQUIREMENTS

- A. Toilet Compartment Manufacturers:
1. Preferred:
    - a) Bradley Corporation; Mills Partitions.
    - b) Hadrian Manufacturing Inc.
    - c) Santana Products, Inc.
    - d) Sanymetal; a Crane Plumbing company.
- B. Toilet Compartment Material:
1. Required: Solid polymer units, for toilet enclosures, entrance screens and urinal screens.
- C. Toilet Enclosures Mounting Style:
1. Required: Ceiling-hung.
  2. Preferred: Floor-and-ceiling anchored (if ceiling-hung is not feasible).



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3. Disallowed:
    - a) Overhead braced.
    - b) Floor anchored.
  
  - D. Entrance Screens Mounting Style:
    1. Required: Ceiling-hung.
    2. Preferred: Floor-and-ceiling anchored.
    3. Disallowed:
      - a) Overhead braced.
      - b) Floor anchored.
  
  - E. Urinal Screens Mounting Style:
    1. Required: Wall-hung.
    2. Disallowed:
      - a) Overhead braced.
      - b) Floor anchored.
      - c) Post to ceiling.
  
  - F. Toilet Accessory Manufacturers:
    1. Preferred:
      - a) A & J Washroom Accessories, Inc.
      - b) American Specialties, Inc.
      - c) Bobrick Washroom Equipment, Inc.
      - d) Bradley Corporation.
  
  - G. Toilet Accessories: Determined on a per-project basis.
- 
4. **INSTALLATION REQUIREMENTS – Not Used**
  
  5. **EVALUATION OR COMMISSIONING – Not Used**

**END OF DOCUMENT**

# FACILITY DESIGN GUIDELINES

## 10 4400 FIRE PROTECTION SPECIALTIES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements for fire extinguishers and fire extinguisher cabinets are described in this Section.
- B. Related Documents: NONE.
- C. The following table summarizes the types of particular requirements identified within this Section:

Requirements listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
X	X	X	

### 2. PROCEDURAL REQUIREMENTS – Not Used

### 3. PRODUCT REQUIREMENTS

- A. Fire Extinguishers:
  - 1. Manufacturer:
    - a) Required: Amerex Corporation.
  - 2. Required Types:
    - a) Multipurpose Dry-Chemical Type. UL-rated 3-A:40-B:C, 5-lb. nominal capacity or 4-A:80-B:C, 10-lb. nominal capacity; with monoammonium phosphate-based dry chemical in enameled-steel container.
    - b) Regular Dry-Chemical Type: UL-rated 40-B:C, 5.5-lb nominal capacity; with sodium bicarbonate-based dry chemical in enameled-steel container.
    - c) Clean-Agent Type: UL-rated 2-A:10-B:C, 15.5-lb nominal capacity, with HCFC Blend B agent and inert material in chrome-plated-brass container; with pressure-indicating gage.
  - 3. Accessories:
    - a) Required: Mounting brackets.
- B. Fire Extinguisher Cabinets:
  - 1. Manufacturer and Product:
    - a) Preferred: Potter Roemer LLC; Break Rite series.
  - 2. Cabinet Material:
    - a) Required: Cold-rolled steel sheet.
  - 3. Material Finish:
    - a) Required: Baked enamel.
  - 4. Cabinet Trim Material:
    - a) Required: Same material and finish as cabinet and door.

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5. Door Glazing:
  - a) Required: Break glass.
6. Accessories:
  - a) Required: Mounting brackets and door locks.

### **4. INSTALLATION REQUIREMENTS**

- A. Disallowed:
1. Prohibition 1: Use of toggle bolts to attach fire extinguisher cabinets and mounting brackets to gypsum board.
  2. Prohibition 2: Use of Molly bolts to attach fire extinguisher cabinets and mounting brackets to gypsum board.

### **5. EVALUATION OR COMMISSIONING – Not Used**

**END OF DOCUMENT**

# FACILITY DESIGN GUIDELINES

## 11 5300 LABORATORY PLANNING

### 1. OVERVIEW

- A. Purpose – USC preferences, requirements and considerations for laboratory planning and safety are outlined in this document.
- B. For other related requirements, refer to Sections 11 5310–Casework, 11 5313–Fume Hoods, 11 5343-Fittings & Fixtures.
- C. The following table summarizes the types of particular requirements identified within this section:

	Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
Submittal of plans for review and approval of Control Areas	X			
“B” Occupancy for Laboratories		X		
Define “Control Areas” for future flexibility of laboratory use		X		
Submittal of plans for review and approval of laboratory zone planning	X			
Submittal for review and approval of systems and equipment to be served by standby power.	X			
Standby power to serve equipment in research labs	X			

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### 2. PROCEDURAL REQUIREMENTS

#### A. Control Areas Planning Process:

##### 1. Required:

- a) Schematic Design: Confirm that the laboratories will be designated as “B” occupancies as preferred by USC. Based on an understanding of the laboratory functions and use of hazardous materials identify proposed “Control Areas” on each floor for review and testing by USC EH&S and FSEP along with representative researchers. Control Areas shall be shown on floor plans as part of the Code Review sheets.
- b) Schematic Design: In collaboration with the University collect types and quantities of hazardous materials as defined in the CBC and NFPA for representative researchers and lab areas. Provide enough information so that FSEP can project quantities of chemicals and hazardous materials with each “Control Area” and test total quantities against maximum allowable limits.
- c) Design Development: Based on comments and / or approval of proposed Control Areas by FSEP further define boundaries of Control Areas for development of rated partitions, doors and other components as well as building systems.
- d) Design Development: If initially proposed Control Areas do not provide the adequate materials flexibility for the University consideration will be given to the use of supplemental “H2” / “H3” occupancy rooms.
- e) Design Development: If MAQs in upper floors of high-rise laboratory buildings are impracticably low to allow for proposed or likely research, consider upgrading to “L” occupancy, or other suitable occupancy as advised by FSEP.
- f) Design Development: Final Design Development drawings shall show the boundaries of all proposed “Control Areas” along with compatible building system separations.
- g) Construction Documents: Final Construction Documents for purpose of submittal to code authorities shall include a Hazardous Materials Management Plan (HMMP) and a Hazardous Materials Inventory Statement (HMIS) as defined by the governing fire authority. The HMMP and HMIS when required shall be developed by or in collaboration with the University EH&S representatives.

#### B. Laboratory Zone Planning for EH&S

##### 1. Required:

- a) Design Team shall meet with University Environmental Health and Safety representatives during the Schematic Design phase.
- b) Drawings shall be submitted to Environmental Health & Safety for review of building planning for the purpose of insuring:
  - 1) Appropriate separation of laboratory and non-laboratory spaces.
  - 2) Separation of food and drink areas from laboratories.
  - 3) Appropriate boundaries and facilities for use of Personal Protection Equipment (PPE).
  - 4) Appropriate zoning of biological designations for BSL1, BSL2 and BSL3 work.
  - 5) Appropriate locations for fume hood and other capture devices away from primary circulation paths.
  - 6) Appropriate locations for safety showers and eye wash units in

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consistent locations near laboratory exit doors.

- 7) Appropriate air flow between laboratories and non-laboratory zones.
- c) Schematic Design: Schematic Design Drawings shall designate all laboratories, rooms and areas by name describing its intended use including biosafety level. Drawings shall show basic laboratory fit-out including benches, fume hoods, sinks, safety shower / eye wash units and student or researchers work stations. Drawings shall show pressure map information identifying intended airflow direction between areas and rooms at door openings.
- d) Schematic Design: Final Schematic Design Drawings shall be submitted to EH&S for review of general planning for laboratory safety.
- e) Design Development: Based on EH&S review comments from Schematic Design Drawings revise designs and drawings to incorporate suggestions / requirements to improve general planning for safety protocols.
- f) Construction Documents: Construction Documents shall incorporate refinements from Design Development review by EH&S and further detail laboratory furnishings and safety equipment to meet all code and EH&S requirements.

### C. Standby Power for Laboratory Equipment

#### 1. Required:

- a) Standby Power shall be provided from an emergency generator and shall be separated from the life safety emergency power distribution system. Standby power shall serve critical laboratory equipment or systems to prevent the loss of samples, materials, procedures or data that is valuable or not replaceable without great effort or investment.
- b) Schematic Design: Review with the University, designated researcher representatives and Environmental Health & Safety representatives the strategy for standby power and specific equipment and systems to be served by standby power.
- c) Teaching laboratories and support: Standby power is not anticipated in teaching laboratories and only considered for special storage or equipment needs in support rooms. Standby power may be considered in teaching laboratory facilities for:
  - 1) Alarm systems for safety showers, CERs, freezer / incubator monitoring
  - 2) Controlled Environment Rooms (including refrigeration equipment)
  - 3) Cadaver storage rooms or units
  - 4) -80°C freezers
  - 5) Incubators
  - 6) Other specific functional needs meeting the criteria for standby power.
- d) Research Laboratories and Support: Standby power shall be provided for:
  - 1) Alarm systems for safety showers, CERs, freezer / incubator monitoring
  - 2) Hazardous gas systems.
  - 3) Hazardous atmosphere monitoring systems and alarms, including toxic gas monitors, carbon dioxide alarms, and oxygen deficiency alarms.
  - 4) All Controlled Environment Rooms (including refrigeration equipment)
  - 5) All -80°C freezers
  - 6) Ventilation systems for spaces which are at risk from oxygen deficiency

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or carbon dioxide toxicity, e.g. liquid nitrogen freezer farms, cryogen storage rooms, refrigerated liquid carbon dioxide storage rooms.

- 7) All Incubators
- 8) One 120v, 20a dedicated circuit for every 900 NSF of research lab area.
- 9) Conditioning systems serving equipment areas housing significant heat producing equipment that is served by standby power.
- 10) Process cooling water systems serving equipment or heat exchangers served by standby power.

### **3. PRODUCT REQUIREMENTS**

A. Not Applicable

### **4. INSTALLATION REQUIREMENTS**

A. Not Applicable

### **5. EVALUATION or COMMISSIONING**

A. Not Applicable

**END OF DOCUMENT**

# FACILITY DESIGN GUIDELINES

## 11 5310 LABORATORY CASEWORK & OTHER FURNISHINGS

### 1. OVERVIEW

- A. Purpose – USC preferences, requirements and considerations for laboratory casework and other furnishings are outlined in this document.
- B. For other related requirements, refer to Sections 11 5343–Fittings & Fixtures, 11 5313-Fume Hoods, 23 0000-Mechanical, 22 0000-Plumbing, 26 0000-Electrical, 23 3500-Specialty Exhaust Systems and 22 6000-Gas and Vacuum systems for Laboratories.
- C. The following table summarizes the types of particular requirements identified within this section:

	Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
Premium Grade wood casework for Research Labs		X		
Custom Grade minimum for wood casework in Research and Teaching Labs	X			
Flammable Storage Cabinets to be vented	X			
Corrosive Storage Cabinets to be vented	X			

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Schematic Design: Casework benching, stand-alone storage cabinets, sinks, safety shower / eyewash stations and fume hoods shall be identified on the final Schematic Design laboratory fit-out drawings. Casework shall



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- be described in detail sufficient to develop cost estimates for laboratory areas.
- b) Design Development: All laboratory casework, fittings, fixtures, safety shower / eyewash stations and fume hoods shall be shown on the final Design Development Drawings and specified in sufficient detail to fully describe all casework components and features including door and drawer configurations.
  - c) Construction Documents: All laboratory Casework, fittings, sinks, safety shower / eyewash stations and fume hoods and exhaust units shall be identified on the final Construction Documents in sufficient detail to competitively bid and construct all casework, fittings, fixtures and safety units with detailed and specific features.
2. Preferred:
- a) Teaching Laboratories: Casework used in undergraduate teaching laboratories should be wood casework fixed where utility or storage requirements dictate. Movable table or bench components are encouraged for reconfiguring teaching laboratories for alternate teaching pedagogies. Metal casework is acceptable and should be considered where laboratory function or timely delivery is a factor. Consideration will be given to alternative casework materials where function and service life allow.
  - b) Research Laboratories: Casework used in Research laboratories should be a combination of fixed wood components where utility or storage requirements dictate and mobile frame systems with movable wood base cabinets and quick connect utility connections for easy reconfiguring of portions of the lab. Fixed metal casework is acceptable and should be considered where function or timely delivery is a factor. Consideration will be given to alternative casework materials where function and service life allow.
  - c) Biosafety Level 2 and Radioisotope Laboratories: Casework used in biosafety level 2 and radioisotope laboratories shall be non-absorbent in labs where chemicals are used and easily cleaned. Metal or Plastic laminate casework is preferred. Consideration should be given to mobile base cabinets for cleanability.
- B. Accessibility considerations for laboratory casework:
1. Teaching Laboratory Application:
    - a) All code requirements for accessibility shall be met and approved by the authority having jurisdiction.
    - b) Each and every teaching laboratory shall be made accessible for students and faculty with disabilities (ADA). Access to and within each student occupied laboratory and laboratory support space must be provided.
    - c) A minimum of 5% of fixed benching shall be made accessible in student occupied laboratories. Student work stations in laboratories shall be made accessible at a ratio of 1:20 and shall include height and knee clearances, fittings and electrical within reach limits.
    - d) Where at least one sink is provided in a teaching laboratory at least one sink (or 5% of all sinks) shall be made accessible. A single depth shallow sink is preferred to accommodate reach restrictions to the bottom of the sink. Considerations will be given to multi-depth sinks that meet all clearance requirements and meet with the approval of the authority having jurisdiction.

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- e) At least one set (or 5% of all sets) of piped service fittings provided for student use shall be made accessible. Accessible fittings shall be within reach limits and incorporate single lever, quarter turn valves and handles.
  - f) All primary safety station equipment including safety showers and eyewash units shall be made accessible.
  - g) Accessible sinks, student station fittings, safety stations and fume hoods should be located in proximity to each other within a teaching laboratory.
2. Research Laboratory Application:
- a) All code requirements for accessibility shall be met and approved by the authority having jurisdiction.
  - b) Research laboratories and casework shall be made accessible as required by code and local authority for researchers, students and faculty with disabilities (ADA). Access to and within each laboratory and laboratory support space shall be provided as required.
  - c) A minimum of 5% of fixed benching shall be made accessible in student occupied laboratories. Student work stations in laboratories shall be made accessible at a ratio of 1:20 and shall include height and knee clearances, fittings and electrical within reach limits.
  - d) Where at least one sink is provided in a teaching laboratory at least one sink (or 5% of all sinks) shall be made accessible. A single depth shallow sink is preferred to accommodate reach restrictions to the bottom of the sink. Considerations will be given to multi-depth sinks that meet all clearance requirements and meet with the approval of the authority having jurisdiction.
  - e) At least one set (or 5% of all sets) of piped service fittings provided for student use shall be made accessible. Accessible fittings shall be within reach limits and incorporate single lever, quarter turn valves and handles.

### 3. PRODUCT REQUIREMENTS

#### A. Laboratory Casework & Other Furnishings

##### 1. Manufacturers:

- a) Preferred Wood Casework Manufacturers:
  - 1) CiF Lab Casework Solutions, 56 Edilcan Drive, Ontario, Canada L4K 3S6 Tel: 905 738-5821.
  - 2) Collegedale Casework, Inc., PO Box 810, Collegedale, TN 37315 Tel: 423 238-4131.
  - 3) Diversified Woodcrafts, Inc., 300 South Krueger Street, Suring, WI 54174 Tel: 920 842-2136.
  - 4) Kewaunee Scientific Corporation, P O Box 1842, Statesville, NC 28687 Tel: 704 873-7202.
  - 5) Mott Manufacturing Limited., 452 Hardy Road, P. O. Box 1120, Brantford, ON, Canada N3T 5T3 Tel: 519 752-7825.
  - 6) Thermo Fisher Scientific, 1316 18th Street, Two Rivers, WI 54241 Tel: 920 793-1121.
  - 7) Mid Canada Millwork, 78 PTH 52 W, Steinbach, Manitoba, Canada R5G 1X8 Tel: 877 262-9663.

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- 8) Valley City Manufacturing, 64 Hatt Street, Dundas, Ontario, Canada L9H2G3 Tel: 905 628-4470.
  - b) Preferred Metal Casework Manufacturers:
    - 1) Bedcolab Ltd, 2305 Francis Hughes Avenue, Laval, Quebec, Canada H7S 1H5 Tel 514 384-2820. [MYH: H2I (FORMERLY DOW) will install, Canada based.]
    - 2) Jamestown Metal Products, Inc., 178 Blackstone Avenue, Jamestown, NY 14701 Tel: 716 665-5313. (MYH: no qualified installers in the region.)
    - 3) Kewaunee Scientific Corporation, P O Box 1842, Statesville, NC 28687 Tel: 704 873-7202. (MYH: ISEC will install)
    - 4) Mott Manufacturing Limited., 452 Hardy Road, P. O. Box 1120, Brantford, ON, Canada N3T 5T3 Tel: 519 752-7825 (MYH: no qualified installers in the region, Canada based.)
  - c) Hazardous Storage Cabinet Manufacturers
    - 1) Eagle Manufacturing Company, 2400 Charles St., Wellsburg, WV 26070 Tel: 304 737-3171.
    - 2) Justrite Manufacturing Company, 2454 Dempster St., Suite 300, Des Plaines, IL 60016 Tel: 800 798-9250.
2. Component Characteristics:
- a) Wood Casework:
    - 1) Teaching Laboratories shall be developed with consideration for casework movability, services distribution and fixed storage. Use of fixed casework and movable tables is encouraged to meet storage and flexibility needs.
    - 2) Research Laboratories shall be developed with consideration for adaptable configurations and flexible casework. Use of mobile laboratory bench systems and fixed bench components is encouraged to provide changeable laboratory environments.
    - 3) Wood is the preferred material for both fixed and mobile laboratory casework components. Consideration may be given to alternative casework materials.
    - 4) Wood casework shall comply with all quality standards of AWI, 8<sup>th</sup> Edition, Custom Grade architectural cabinets as a minimum standard. AWI, 8<sup>th</sup> Edition, Premium Grade architectural cabinets is the preferred standard for Research Laboratories.
    - 5) Casework shall be manufactured in accordance with recognized standards from the Scientific Equipment and Furniture Association: SEFA 8W-2007 Recommended Practices for Laboratory Grade Wood Casework.
    - 6) Composite Wood Products – Composite wood products shall comply with the California Code of Regulations: Title 17, Section 93120: Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products.
    - 7) Certified Wood: All wood products used in the fabrication shall comply with the FSC's (Forest Stewardship Council's) Principles and Criteria as required to contribute towards USGBC LEED 2.2 Credit MR7
    - 8) Low-Emitting Materials – Composite Wood and Agrifiber Products: Composite wood and agrifiber products used in casework products shall contain no added urea-formaldehyde resins, as required to meet USGBC LEED 2.2 Credit EQ4.4

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- 9) Rapidly Renewable Materials – Provide rapidly renewable materials, as listed below, made from plants that are typically harvested within a ten-year cycle or shorter, as required to contribute towards USGBC LEED 2.2 Credit MR6.
- 10) Wood products as listed below shall contain recycled content to contribute towards achievement of the USGBC LEED Green Building Rating System MR Credits 4.1 and/or 4.2
- 11) For every project which includes more than 20,000 NSF of laboratory casework mockups shall be constructed and assembled in accordance with the construction documents. Adjustments, modifications and corrections required to meet the specifications shall be incorporated into the production and installation of the entire casework scope as no additional cost to the University. Mockup shall include representation of all casework components including fixed and mobile casework, shelving, sinks and fittings, fume hoods and other specific components as identified in the construction documents. Consideration will be given to mockups for projects of less than 20,000 NSF of laboratory. Once installed the mockup shall be maintained at the project site for use as a construction standard.
- 12) Design for wood casework door and drawers shall be square edged full flush overlay design with eased edges, 5/16 inch (8mm) top and bottom reveal and 5/32 inch (4mm) reveal horizontal and vertical and 1/16 inch (2mm) vertical reveal on ends of cabinets. Grain shall be vertically matched, book matched and sequence matched. Door and drawer pulls shall be stainless steel 4" wire pulls.
- 13) Preferred wood species and veneer cut shall be plain slice white select maple. Consideration will be given to alternate species and veneer cuts with approval from USC
- 14) Specific laboratory environments may require casework of alternate materials including stainless steel, phenolic resin, polypropylene, etc.
- 15) Preferred casework hardware includes 4" stainless steel wire pulls, 5 knuckle stainless steel hinges and full extension drawer slides rated at 150 lb. minimum at full extension.
- 16) Mobile laboratory bench system for flexibility and mobility research labs shall include welded self-supporting framework with slotted shelf uprights and adjustable height legs. The system shall accommodate piped services integrated into the vertical frame with quick connects to integrated ceiling utility panels. Electrical raceway shall be integral with the system including twist lock connection to ceiling utility panels. Base cabinets shall be finished all sides and fit out with casters for mobility.
- 17) Hazardous Storage Cabinets shall comply with the requirements NFPA 30, the Los Angeles Fire Code with UL 1275. Cabinets shall be purpose built for the storage of flammable or combustible liquids, solvents or corrosives. Flammable Storage Cabinets shall be so labeled and shall be vented in accordance with local authorities having jurisdiction and in such a manner as to not void the flame

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separation function if venting is determined by Environmental Health and Safety to be appropriate. Corrosive cabinets shall be so labeled and vented into the interior of a fume hood or directly to the fume hood exhaust system.

1. Most labs will require TWO corrosive cabinets (to segregate acids and bases) and some will require THREE (to segregate bases, oxidizing/inorganic acids, and organic acids). Some chemistry labs may even require more than three corrosive cabinets. Include EH&S in discussions with the PI to ensure appropriate provision of corrosive cabinets is determined at an early stage in the design process.
- b) Work surfaces
- 1) Preferred Manufacturers
    - (a) Durcon Laboratory Tops, Inc., 206 Allison Drive, Taylor, TX 76574 Tel: 512-595-8000.
    - (b) Epoxyn Products, 500 E. 16<sup>th</sup> Street, Mountain Home, AR 72653 Tel: 870 425-4321.
    - (c) Kewaunee Scientific Corporation, P O Box 1842, Statesville, NC 28687 Tel: 704 873-7202.
  - 2) 1" thick, 1/4" radius eased edge epoxy work surface is the preferred laboratory benchtop material. Benchtops at fume hoods shall be 1-1/4" thick at exposed edges with a dished 1" worksurface.
  - 3) Preferred color is Black. Consideration will be given to alternative colors.
  - 4) All epoxy resin used in the project shall contain recycled content to contribute towards achievement of the USGBC LEED Green Building Rating System MR Credits 4.1 and/or 4.2
  - 5) Alternative benchtop materials will be considered for specific uses including stainless steel, phenolic resin, polypropylene and plastic laminate.
- c) Shelving Systems shall include High-pressure decorative laminate bonded to 1" thick shop sanded exterior grade veneer plywood with 3 mm PVC edge banding or wood veneer over 1" thick shop sanded exterior grade veneer plywood with solid wood edge banding.
- d) Safety rails at shelving shall be 1/4" stainless steel removable rods set at all unrestrained edges of each shelf.
- e) Shelving supports at island benches shall be 2"x3" powder coated steel tubes anchored to the floor extending through the benchtop to a minimum height of 84" above the floor. Vertical support tubes shall be slotted for adjustable shelving brackets.
- f) Pipe drop enclosures shall be used for vertical routing of conduit, piped services and exhaust from ceiling to bench without embedding in a wall. The enclosure shall be powder coated steel and used to distribute conduit and piped services to wall and island benches. Easily removable access panels shall provide access to a chase for routed electrical and plumbing bench services.
- g) Drying racks shall be stainless steel with white polypropylene removable pegs and a drained drip pan. Other material may be considered including epoxy.
- h) Cylinder rack assembly shall consist of powder coated 2" x 2" steel tubes

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welded together allowing two standard cylinders to be secured in one cell with 5/16 inch diameter, Type 304 stainless steel welded chain fitted with stainless steel snap shackle with swivel clevis at two levels. Consideration will be given to cylinder rails at two horizontal levels fabricated of powder coated steel Unistrut mounted on a wall or side of a fume hood instead of a rack assembly. Cylinder racks or rails shall be planned in all research labs for future use.

- 1) All cylinder racks or other mounts shall be securely bolted to a non-combustible fixed surface (preferably the wall or floor). All cylinder racks or other mountings shall have provision for individual double-chaining of cylinders. (Securement of multiple cylinders by the same chain, and securement of cylinders by combustible restraints such as ropes or straps, are not permitted.)

### **4. INSTALLATION REQUIREMENTS**

#### **A. Required:**

1. Work in this section requires close coordination with Work specified In Divisions
  - a) 115313 – Fume Hoods & Other Exhaust Units
  - b) 115343 – Laboratory service fittings & fixtures
  - c) 220000 - Plumbing
  - d) 230000 - Mechanical
  - e) 260000 - Electrical
2. Work in this section requires close coordination with Owner furnished components and equipment.

### **5. EVALUATION or COMMISSIONING**

#### **A. List of items or systems requiring testing, evaluation, verification, or commissioning:**

1. Provide certified test reports indicating compliance of casework finish and bench top materials resistance to chemical and physical conditions outlined.

**END OF DOCUMENT**

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## 11 5313 FUME HOODS & OTHER EXHAUST UNITS

### 1. OVERVIEW

- A. Purpose – USC preferences, requirements and considerations for Fume Hood design are outlined in this document.
- B. For other related requirements, refer to Sections 11 5310–Casework, 11 5343–Fittings & Fixtures, 23 0000-Mechanical, 22 0000-Plumbing, 26 0000-Electrical, 23 3500-Specialty Exhaust Systems and 22 6000-Gas and Vacuum systems for Laboratories.
- C. The following table summarizes the types of particular requirements identified within this section:

	Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
Variable Air Volume Fume Hood and Controls		X		
Vertical Sash		X		
Each Fume Hood				X
Occupancy Sensors – VAV Hoods	X			

- D. The following table summarizes the fume hood design parameters for sizing fume hood exhaust systems.

Fume Hood Type	Sash Opening Design Position	Minimum Face Velocity for Occupied Hood at Sash Design Position (Notes 1 and 2)	Maximum Face Velocity at Sash Design Position
Standard Vertical Sash Teaching Lab Fume Hood	18"	100 FPM	110 FPM
Standard Vertical Sash Research Fume Hood	18"	100 FPM	110 FPM

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Combination Sash	Horizontal sash closed; vertical sash open 18"	100 FPM (to fulfill Cal/OSHA requirements)	110 FPM
	Vertical Sash open (50%); horizontal Sash closed	≥100 fpm	N/A
Regulated-carcinogen hood (Notes 3 and 4)	18"	150 fpm (Note 5)	175 fpm???
Radioisotope hoods (Notes 6 and 7)	18"	100-150 fpm depending on radioisotope; consult EH&S for determination based on the specific isotope(s) to be used.	110-175 fpm????

1. Face velocities shall be compliant with Cal/OSHA §5154.1. "Ventilation Requirements for Laboratory-Type Hood Operations" except where other Cal/OSHA regulations specify more stringent requirements (e.g. §5209. "Carcinogens"). Cal-OSHA §5154.1 requirements are "...an average face velocity of at least 100 feet per minute with a minimum of 70 fpm at any point... The minimum velocity requirement excludes those measurements made within 1 inch of the perimeter of the work opening."
2. Minimum face velocities for unoccupied regular (i.e. NOT regulated carcinogen or radioisotope) hoods may be decreased by 20%. Any reduction below a mean of 100 fpm for an unoccupied hood shall be in accordance with Cal/OSHA §5154.1 (c)(2) and sub-clauses. Note that these requirements include specific tracer-gas testing protocols during commissioning, and a recordkeeping requirement for test results (lifetime of the hood plus five years). FPM shall retain said records. For regulated-carcinogen hoods, see Note 3, below.
3. The thirteen carcinogens regulated under Cal/OSHA §5209 require an "...average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute..." (§5209 (b)(11)). The minimum is to be taken as the minimum for any point measurement (excepting measurements taken within one inch of the sides of opening). The average of measurements taken across the broad area of the opening shall be at least 150 fpm.
4. Regulated-carcinogen hoods shall be prominently and permanently signed at time of installation: "Regulated carcinogen hood – 150 fpm face velocity". (Of if the design average face velocity is some other number in excess of 150 fpm, this number should be specified on the sign.)
5. Hoods for the thirteen Cal/OSHA regulated carcinogens shall NOT decrease face velocity when unoccupied except in cases specifically approved by EH&S. However, automatic sash closure is acceptable and to be preferred for energy efficiency.
6. Any hood with a design minimum average face velocity exceeding 100 fpm shall be prominently and permanently signed with the designed face velocity. However, FPM signage shall NOT include the term "radioisotope" or the radiation warning symbol. (Responsibility for provision and removal of regulatory-compliant radiation warning signage lies with the EH&S radiation safety program.)
7. Radioisotope hoods shall NOT decrease face velocity when unoccupied except in cases specifically approved by EH&S. However, automatic sash closure is



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acceptable and to be preferred for energy efficiency.

### 8. PROCEDURAL REQUIREMENTS

#### A. Design considerations specific to components in this section:

##### 1. Required:

- a) Schematic Design: All fume hoods and exhaust units shall be identified on the final schematic Design Laboratory fit-out drawings. Fume Hoods, Biosafety Cabinets and exhaust devices shall be described in detail sufficient to develop preliminary exhaust system loads and cost estimates.
- b) Design Development: All fume hoods and exhaust units shall be identified on the final Design Development Drawings and specification in sufficient detail to develop exhaust system designs and accurate loads. Fume hoods, biosafety cabinets and exhaust units shall be described in sufficient detail to identify incorporated or related piped services, power and specialty cabinet requirements.
- c) Construction Documents: All fume hoods, biosafety cabinets and exhaust units shall be identified on the final Construction Documents in sufficient detail to competitively bid and install hoods and units with detailed and specific features.

##### 2. Preferred:

- a) Teaching Laboratories: Fume hoods used in undergraduate teaching laboratories should be 6 foot wide vertical sash, flush sill units with integrated power and piped service fittings which may include lab vacuum. Consideration will be given to integrated cold water, natural gas and compressed air. Consideration will be given for 8 foot wide fume hoods with vertical split sashes where appropriate. Consideration will be given for 4 foot wide vertical sash fume hoods where need is minimal or supplemental. Consideration will be given for full view fume hoods where safety is enhanced by glass-sided units. All hoods shall include occupancy or proximity sensors for control of exhaust valve.
- b) Research Laboratories: Fume hoods used for research laboratories should be 6 foot or 8 foot wide vertical sash, flush sill units with power and integrated piped service fittings required for specific use which may include cold water and lab vacuum, natural gas, compressed air and nitrogen. Consideration will be given to combination sash units and / or horizontal sliding face shields where functionally beneficial. Research laboratory fume hoods should include lattice rod assemblies at interior and purpose-built hazardous materials storage cabinets below including one flammable and one corrosive cabinet. All hoods shall include occupancy or proximity sensors for control of exhaust valve.
  - i. Many research labs will require TWO corrosive cabinets (to segregate acids and bases) and some will require THREE (to segregate bases, oxidizing/inorganic acids, and organic acids). Some chemistry labs may even require more than three corrosive cabinets. Include EH&S in discussions with the PI to ensure appropriate provision of corrosive cabinets is determined at an early stage in the design process.

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- c) Variable Air Volume controlled fume hoods are recommended except that Constant Volume exhaust hoods may be considered in those situations/conditions/laboratories where a reduction in exhaust volume gained from a VAV control system will not reduce the overall, continuous exhaust from that laboratory.
- B. Accessibility Considerations for Fume Hoods:
- 1. Teaching Laboratory Application:
    - a) All code requirements for accessibility shall be met and approved by the authority having jurisdiction.
    - b) Where at least one fume hood is installed in a teaching laboratory or teaching lab support area at least one (of every 20) shall be made accessible.
    - c) Accessible fume hood features include work surface height at 34" or lower, knee opening of 27" or higher and service fittings, electrical receptacles, light switch and alarm silencing button within accessible reach height limits.
    - d) Accessible fume hoods should be located in proximity to other accessible workstations or sinks within the laboratory.
  - 2. Research Laboratory Application:
    - a) All code requirements for accessibility shall be met and approved by the authority having jurisdiction.
    - b) Where at least one fume hood is installed in a research laboratory at least one (of every 20) shall be made accessible.
    - c) Accessible fume hood features include work surface height at 34" or lower, knee opening of 27" or higher and service fittings, electrical receptacles, light switch and alarm silencing button within accessible reach height limits.
    - d) Accessible fume hoods should be located in proximity to other accessible workstations or sinks within the laboratory.

### 3. PRODUCT REQUIREMENTS

- A. Bench Mounted Chemical Fume Hoods
- 1. Manufacturers:
    - a) Preferred:
      - 1) Jamestown / Isolator (MYH: no qualified installers in the region)
      - 2) Kewaunee Scientific / Supreme Air Series (MYH: ISEC will install)
      - 3) Labconco / Protector (MYH: H2I (formerly DOW) will install)
      - 4) Mott Manufacturing Limited / Sigma Systems (MYH: no qualified installers in the region & Canada based)
      - 5) Thermo Fisher Scientific / SafeAire II or Concept
  - 2. Component Characteristics:
    - a) Liner:
      - 1) Preferred white homogeneous polyester, 3/16" minimum thickness
      - 2) Consideration given to alternate liners including stainless steel or polypropylene for specific functions.
    - b) Work Surface:
      - 1) Preferred dished epoxy work surface.
      - 2) Color of Hood work surface shall be black, except that consideration will be given to alternative benchtop colors that may enhance functionality.

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- 3) Consideration given to alternate work surfaces including stainless steel or polypropylene for specific functions.
- c) Cup Sinks:
  - 1) Cup Sinks should only be provided to fume hoods where cold water is required for specific functionality.
  - 2) Where required preferred raised rim, black epoxy, drop-in, oval shaped cup sink at fume hoods.
  - 3) Consideration given to larger rectangular epoxy cup sinks or integral stainless steel cup sinks for specific functions.
- d) Safety Monitor / Alarm:
  - 1) Required – (for CAV fume hoods) Continuously operating, field calibratable and programmable, airflow monitoring device mounted at front of fume hood shall provide audible and visual alarm and FPM readout with digital display. Provide for remote alarm connections.
  - 2) Required – (for VAV fume hoods) Coordinate cut-out and controls installation for fume hood alarm as a component of the HVAC controls system. Safety monitor / alarm shall be provided by the controls manufacturer and compatible with the fume hood exhaust valve.
  - 3) Monitors/alarms shall fulfill the requirements of Cal/OSHA §5154.1 (e)(3)(a).
- e) Occupancy Sensors:
  - 1) Required – coordinate cut-out and controls installation for fume hood occupancy (proximity) sensor. Occupancy sensor shall be provided by the controls manufacturer and shall be compatible with the fume hood exhaust valve.
- f) Baffles:
  - 1) Prefer fixed baffles with adjustability prior to final fixed setting.
  - 2) Consideration given to adjustable, single point control baffles for specific functions.
- g) Sash Design:
  - 1) Preferred – Vertical rising, frameless, laminated safety glass sash for teaching laboratory and research laboratory fume hoods.
  - 2) Consideration given to combination vertical and horizontal sash for research laboratory fume hoods.
  - 3) Consideration given to split vertical sash for fume hoods wider than 8 feet.
- h) Sash automation
  - 1) For hoods which reduce face velocity when unoccupied, and variable volume hoods in general, automatic closing of the sash is preferred for safety and energy efficiency.
  - 2) Sash automatic-closing function should be enabled by default, but users should have the ability to easily disable or re-enable this function, in accordance with changing research needs.
  - 3) Forbidden – Automatic sash opening. Fume hood sashes shall NOT automatically open based on proximity.
- i) Service Fittings:
  - 1) Required – Color coded, powder coated fittings inside the fume hood shall be factory piped inside fume hood walls with remote front-loaded valves for access and maintenance from front post of fume hood. No additional holes allowed in fume hood posts for services other than specified.
  - 2) Required: All fittings and associated pipework shall be signed and

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labeled in accordance with Cal-OSHA §3321, and preferably also according to the standard ANSI/ASME A13.1 – 2020 (or more recent version).

- j) Lattice Rod Assembly:
  - 1) Provide at all research fume hoods. Consideration given to Organic Chemistry teaching laboratories and other specific functional needs in teaching laboratories.
  - 2) Preferred – ½ inch diameter extruded solid anodized aluminum rods, 12 inches on center, horizontally and vertically. Lengths as required such that vertical rods are 4 inches (100 mm) from the rear baffle of the fume hood. Anchor rods to work surface and interior sides of fume hood.
- k) Enclosure Panel:
  - 1) Preferred – Provide enclosure panel between the top of the fume hood and the ceiling. Panel shall include simple-to-operate means of access to the hood lighting fixture. Finish shall match fume hood superstructure exterior. Panel shall conceal view of the sash when the sash is in the open position. Provide sash pocket if required to allow correct operation of the bypass.
- l) Exhaust Duct Transition Piece:
  - 1) Required – Supplied by the fume hood manufacturer for installation by the mechanical system contractor. Provide contoured Type 316L stainless steel, minimum 18-gauge, exhaust duct transition piece to connect to the fume hood exhaust duct collar and Laboratory exhaust duct system as shown on the Mechanical Drawings.
  - 2) All ductwork shall be signed and labeled in accordance with Cal-OSHA §3321, and preferably also according to the standard ANSI/ASME A13.1 – 2020 (or more recent version).
- m) Lighting:
  - 1) Each fume hood shall include a factory installed individually controlled intrinsically safe (explosion proof) fluorescent light fixture sealed above the fume hood liner. Lamps shall be accessible from the top of the fume hood.
- n) Electrical:
  - 1) Required – Prewired, flush mounted, 125V / 20A / 60Hz duplex type, single gang, NEMA 5-20R, 3-wire, grounding type receptacle, on each side of fume hood, with brushed stainless steel cover plate. Consideration given to additional prewired receptacles and circuits as required by specific functional requirements.

### B. Floor Mounted Chemical Fume Hoods

- 1. Floor Mounted Chemical Fume Hoods (Walk-in Fume Hoods) are considered special use Fume Hoods and shall be considered relative to the specific functional need. Specialty Fume Hoods shall be discussed and reviewed with USC EH&S.

### C. Radioisotope and Regulated-Carcinogen Hoods

- 1. Radioisotope and regulated-carcinogen hoods are considered special use hoods and shall be considered relative to the specific functional need. If required shall be served by an independent duct run and exhaust fan and filter units. Specialty Fume Hoods shall be discussed and reviewed with USC EH&S.

### D. Perchloric Acid Hoods

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1. Perchloric Acid Hoods are considered special use Fume Hoods and shall be considered relative to the specific functional need. If required shall be served by an independent duct run and exhaust fan unit and wash-down system. Specialty Fume Hoods shall be discussed and reviewed with USC EH&S.
- E. Specialty Acid Hoods
1. Specialty Acid Hoods are considered special use Fume Hoods and shall be considered relative to the specific functional need. If required shall be served by an independent duct run and exhaust fan unit. Specialty Fume Hoods shall be discussed and reviewed with USC EH&S.
- F. Nano Particle Hoods
1. Nano Particle Hoods are considered special use Fume Hoods and shall be considered relative to the specific functional need. If required shall be served by an independent duct run and exhaust fan and filter units. Specialty Fume Hoods shall be discussed and reviewed with USC EH&S.
- G. Biological Safety Cabinets
1. Manufacturers:
    - a) Preferred:
      - 1) The Baker Company, Inc., P.O. Drawer E, 161 Gatehouse Road, Sanford, ME 04073 Tel: 800 992-2537.
      - 2) Kewaunee Scientific Corporation, P.O. Box 1842, Statesville, NC 28687 Tel: 704 873-7202.
      - 3) Labconco Corporation, 8811 Prospect Avenue, Kansas City, MO 64132 Tel: 800 821-5525.
      - 4) NuAire, Inc., 2100 Fernbrook Lane, Plymouth, MN 55447 Tel: 800 328-3352.
      - 5) Thermo Fisher Scientific, P.O. Box 649, Marietta, OH 45750 Tel: 740 373-4763.
  2. Component Characteristics
    - a) Class II, Type A2 Vertical Laminar Flow Biological safety cabinets shall be utilized unless noted otherwise. BSCs shall recirculate 70% of air in cabinet; 30% of air filtered and exhausted from common plenum. All accessories shall be pre-piped and pre-wired to single point connection at 6 inches (150 mm) above top of cabinet or as otherwise shown. Nominal 6' and 4' wide BSCs are acceptable.
    - b) Class II, Type A2 BSCs can be recirculated into the laboratory or canopy (thimble / air gap) connected to laboratory exhaust system.
    - c) Consideration shall be given to Class II, Type B2 hard ducted fully exhausted biological safety cabinets where functional requirements include work with volatile and hazardous materials.
    - d) Interior Work Height shall be 27-1/4 inches (692 mm), nominal with overall height of 63 inches (1600 mm), nominal, not including stand.
    - e) Work Surface shall be 16 gauge (1.6 mm), Type 304 stainless steel, with No. 4 finish. Liner/Interior Sidewalls: 16 gauge (1.6 mm), minimum, Type 304 stainless steel, with No. 4 finish. Exterior finish shall be white baked enamel.
    - f) Glass shall be 1/4 inch (6.35 mm) tempered safety glass.
    - g) Germicidal ultraviolet light with UV light interlock, allowing UV illumination only when sash is fully closed.
    - h) UV light is a depreciated sterilization method for biosafety cabinets and

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adds significant hazard.

- 1) Preferred – NO UV light.
  - 2) If user has a technical requirement for UV light installation, and EH&S approves, germicidal UV light may be installed, PROVIDED:
    - 1) Electrical interlock is present, allowing UV illumination only when sash is FULLY closed. (If sash is of a design which cannot fully close then UV light installation is PROHIBITED.)
    - 2) UV light is non-ozone producing (i.e. does not produce extremely short wavelengths)
  - i) Work surface height shall be adjustable between 30 inches (762 mm) and 36 inches (914 mm) above finished floor. Consider motorized stands for accessible stations.
  - j) Unit must be listed by NSF International as meeting NSF/ANSI Standard #49
  - k) Do not pipe natural gas to biological safety cabinets.
- H. Exhaust Extractor Arms (Snorkels)
1. The use of exhaust snorkels shall be limited to nuisance odors. Exhaust snorkels are not a substitute for certified capture devices used with hazardous materials or fumes.
  2. Manufacturers:
    - a) Preferred:
      - 1) Alsident System represented by Laboratory Enterprises, 3122 Brinkerhoff Road, Kansas City, KS 66115 Tel: 913 621-7337
      - 2) Movex Inc., 104 Commerce Drive, Suite C, Northampton, PA 18067 Tel: 610 440-0478.
      - 3) Movex Inc., 104 Commerce Drive, Suite C, Northampton, PA 18067 Tel: 610 440-0478
  3. Component Characteristics:
    - a) Extractor Arm:
      - 1) Preferred - Extruded anodized aluminum 3 inch or 4 inch diameter round tube.
    - b) Swivel Connections:
      - 1) Preferred - White polypropylene connections with manual thumb turn friction joints allowing 180 degree elbow and 360 degree pivot.
    - c) Mounting:
  4. Specialty Extractor Arms (Snorkels)
    - a) Extractor arms for specialty exhaust Including high heat exhaust, welding exhaust, etc. are considered specialty exhaust units and will be considered based on specific functional requirements. Specialty exhaust units shall be discussed and reviewed with USC EH&S.
- I. Local exhaust for furnaces and ovens
1. When furnaces or ovens are to be used with hazardous materials in manner which might result in evolution of hazardous gases, fumes, or dusts, selection of appropriate methods of local exhaust ventilation shall be discussed and reviewed with USC EH&S.

## 4. INSTALLATION REQUIREMENTS

### A. Required:

1. Work in this Section requires close coordination with Work specified in Divisions:
  - a) Electrical 260000

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- b) Mechanical 230000
- c) Plumbing 220000
- 2. Work in this Section requires close coordination with Owner furnished components and equipment.
- 3. Refer to National Institutes of Health Design Requirements Manual [https://orf.od.nih.gov/TechnicalResources/Bioenvironmental/Documents/BiosafetyCabinetBSCPlacementRequirements\\_508.pdf](https://orf.od.nih.gov/TechnicalResources/Bioenvironmental/Documents/BiosafetyCabinetBSCPlacementRequirements_508.pdf)

### 5. EVALUATION or COMMISSIONING

- A. Fume hood field tests shall be performed by a qualified independent testing company on each hood for Flow Visualization, Face Velocity and Tracer Gas Containment for As-Installed (AI) operating conditions. All laboratory supply, general exhaust, and fume exhaust HVAC systems shall be operational during testing.
- B. Balance, test and certify each fume hood in accordance with ASHRAE Standard 110 (latest edition) for Flow Visualization, Face Velocity, and Tracer Gas Containment testing requirements.
- C. Smoke Flow Visualization Test: Fume hood shall provide complete containment of the smoke generated within the hood.
- D. Face Velocity Test: Fume hoods shall achieve the design average face velocity within  $\pm 5$  fpm. Individual face velocity readings shall not vary by more than 20% of the mean between measurement grid locations.
- E. Tracer Gas Challenge Test: Fume hoods shall achieve an As-Installed (AI) performance rating equal or better than 0.10 ppm with 4.0 Lpm tracer gas release rate when tested in accordance with ASHRAE Standard 110
- F. Balance, test and certify each biological safety cabinet in accordance with Annex F Field Tests appended to National Sanitation Foundation (NSF) Standard 49 "Class II (Laminar Flow) Biohazard Cabinetry".
- G. Biological safety cabinet field tests shall be performed by an independent NSF-accredited testing company.
- H. Balancing of the HVAC systems is in the scope of work of Division 23 0000

**END OF DOCUMENT**

# FACILITY DESIGN GUIDELINES

## 11 5343 LABORATORY SERVICE FITTINGS & FIXTURES

### 1. OVERVIEW

- A. Purpose – USC preferences, requirements and considerations for laboratory fittings and fixtures are outlined in this document.
- B. For other related requirements, refer to Sections 11 5310–Casework, 11 5313–Fume Hoods, 23 0000-Mechanical, 22 0000-Plumbing, 26 0000-Electrical, 23 3500-Specialty Exhaust Systems and 22 6000-Gas and Vacuum systems for Laboratories, 09 6000-Flooring.
- C. The following table summarizes the types of particular requirements identified within this section:

	Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
Epoxy Drop-In Sinks	X			
Satin Chrome Fitting Finish		X		
Clear solvent resistant epoxy coat finish on fittings	X			
Combination safety shower / eye wash Units		X		
Tempered water supplied to all safety shower & eye wash units	X			
Dual-purpose eye wash/drench hose unit			X	

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:



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1. Required:
  - a) Schematic Design: All sinks, safety shower / eyewash stations and fume hoods shall be identified on the final Schematic Design laboratory fit-out drawings. Required clear areas around safety showers and eye wash units shall be shown on the drawings. Location of laboratory fittings shall be described in detail sufficient to develop basic piped system densities and cost estimates for laboratory areas.
  - b) New safety shower / eyewash units shall be installed within labs and shall NOT be installed in corridors.
  - c) Design Development: All laboratory fittings, fixtures, safety shower / eyewash stations and fume hoods shall be identified on the final Design Development Drawings and specification in sufficient detail to quantify counts and develop loads.
  - d) Construction Documents: All laboratory fittings, sinks, safety shower / eyewash stations and fume hoods and exhaust units shall be identified on the final Construction Documents in sufficient detail to competitively bid and install all fittings, fixtures and safety units with detailed and specific features. Required clear areas shall be permanently identified in the flooring pattern around safety showers and eye wash units with contrasting colors.
2. Preferred:
  - a) Laboratory Sinks: Drop-in epoxy sinks with minimum dimensions of 21" side to side x 17" front to back x 10" deep with color to match epoxy benchtop.
  - b) Laboratory Fittings: Satin chrome with an acid- and solvent-resistant, clear epoxy coat finish specifically designed for laboratory use. All service fittings shall be of the tapered body design with four arm handles.
  - c) Dedicated handwashing sink located near lab exit: This sink should be fitted with faucets which can be operated hands-free via elbows, or (preferably) via proximity detector. A soap dispenser and paper towel dispenser should be provided. The sink should be signed to indicate its handwashing function (to discourage other uses). The handwashing sink shall be provided in addition to and not in lieu of other lab sinks intended for laboratory uses.
    - In tissue culture rooms and other rooms handling biohazards, dedicated handwashing sink is upgraded from *preferred* to *required*.

### B. Accessibility Considerations for laboratory fittings and fixtures:

1. Teaching Laboratory Application:
  - a) All code requirements for accessibility shall be met and approved by the authority having jurisdiction.
  - b) Where at least one sink is provided in a teaching laboratory at least one sink (or 5% of all sinks) shall be made accessible. A single depth shallow sink is preferred to accommodate reach restrictions to the bottom of the sink. Considerations will be given to multi-depth sinks that meet all clearance requirements and meet with the approval of the authority having jurisdiction.
  - c) At least one set (or 5% of all sets) of piped service fittings provided for student use shall be made accessible. Accessible fittings shall be within reach limits and incorporate single lever, quarter turn valves and handles.
  - d) All primary safety station equipment including safety showers and eyewash units shall be made accessible.

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- e) Accessible sinks, student station fittings, safety stations and fume hoods should be located in proximity to each other within a teaching laboratory.
- 2. Research Laboratory Application:
  - a) All code requirements for accessibility shall be met and approved by the authority having jurisdiction.
  - b) Where at least one sink, work station or safety station is located in a research laboratory at least one (or 5% of all sinks) shall be made accessible. A single depth shallow sink is preferred to accommodate reach restrictions to the bottom of the sink.
  - c) At least one set (or 5% of all sets) of piped service fittings provided for student use shall be made accessible. Accessible fittings shall be within reach limits and incorporate single lever, quarter turn valves and handles.
  - d) All primary safety station equipment including safety showers and eyewash units shall be made accessible.
  - e) Accessible sinks, research station fittings, safety stations and fume hoods should be located in proximity to each other within a research laboratory.

### 3. PRODUCT REQUIREMENTS

#### A. Laboratory Sinks

- 1. Manufacturers:
  - a) Preferred:
    - 1) Durcon
    - 2) Lab Tops
    - 3) Epoxyn
- 2. Component Characteristics:
  - a) Laboratory Sinks: Epoxy laboratory sinks, for drop-in installation in epoxy work surfaces. Color to match benchtop. Sinks to include tailpiece for connection to laboratory waste.
  - b) Cup Sinks: Epoxy, oval shaped drop-in flush installation at laboratory benches. Epoxy, oval shaped top set with raised lip at fume hood bench installations. Color to match benchtop. Sinks to include tailpiece for connection to laboratory waste. Consideration will be given to larger rectangular shaped cup sinks where specific function requires.
  - c) Handwashing sinks: Pending further coordination w/ Section 22 3000-Plumbing Fixtures.

#### B. Laboratory Fittings

- 1. Manufacturers:
  - a) Preferred:
    - 1) Water Saver Faucet Co., 701 West Erie Street, Chicago, IL 60610  
Tel: (312) 666-5500.
    - 2) T&S Brass and Bronze Works, Inc., 2 Saddleback Cove, P. O. Box 1088, Travelers Rest, SC 29690 Tel: (800) 476-4103.
    - 3) Broen represented by Laboratory Enterprises, 3122 Brinkerhoff Rd. Kansas City, KS 66115 Tel: (913) 621-7337.
- 2. Component Characteristics:
  - a) All service fittings and fixtures shall be specifically designed for laboratory use.
  - b) All service fittings shall be factory pre-assembled and individually factory tested.
  - c) All fittings shall have plastic colored service index buttons as specified

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herein.

- 1) Cold Water – Dark Green
  - 2) Hot Water - Red
  - 3) Lab Vacuum - Yellow
  - 4) Lab Compressed Air – Dark Blue
  - 5) Natural Gas - Orange
  - 6) Nitrogen Gas - Brown
- d) All fittings and associated pipework shall be signed and labeled in accordance with Cal-OSHA §3321, and preferably also according to the standard ANSI/ASME A13.1 – 2020 (or more recent version).
  - e) Water valves shall include a renewable unit containing all the working parts which are subject to wear. All water fittings shall withstand test of 80 lbs per sq. in. (0.55 MPa) water pressure
  - f) High purity water valves shall be satin chrome cast brass with polypropylene liner. Valve stem and bonnet shall be brass
  - g) Needle Valves: Fully assembled and factory tested at 225 psi (1.55 MPa) air pressure. Gas, air and vacuum needle valve fittings shall have stainless steel replaceable floating cone that is precision ground and self-centering which shall seat against a stainless steel or monel renewable valve seat. Action of valve shall be slow compression for fine control under pressure up to 150 psi (1.03 MPa) and shall have subject-to-wear parts easily replaceable. Needle valves for natural (laboratory) gas service shall be certified for use with natural gas by the Canadian Standards Association under ANSI Z21.15-1997/CGA9.1-M97
  - h) Laboratory Ball Valves: Suitable for laboratory gas, air and vacuum and be supplied fully assembled and factory tested at 125 psi (0.86 MPa) air pressure. Ball valves shall be of quarter-turn (closed to fully open) design, be fitted with lever handle requiring less than 5 lbf (22 N) force to operate, and shall have subject-to-wear parts easily replaceable. Ball valves for natural (laboratory) gas service shall be certified for use with natural gas by the Canadian Standards Association under ANSI Z21.15-1997/CGA9.1-M97.
  - i) Laboratory gas, air and vacuum valves at workstations indicated to be accessible to persons with disabilities (ADA): Provide ball valves fitted with lever-type handles and screw on index (identification) discs.
  - j) Laboratory plug and socket (2-piece) quick connect service fittings for all 60 - 100 psi compressed air fittings and processed chilled water supply and return fittings.

### C. Emergency Laboratory Plumbing Fixtures

#### 1. Manufacturers:

##### a) Preferred:

- 1) Water Saver Faucet Co., 701 West Erie Street, Chicago, IL 60610  
Tel: 312 666-5500.
- 2) Guardian Equipment, 1104N North Branch St., Chicago, IL 60642  
Tel: 312 447-8100.
- 3) Haws Corporation, 1455 Kleppe Lane, Sparks, NV 89431 Tel: 775  
359-4712.

#### 2. Component Characteristics:

- a) All emergency plumbing fixtures shall comply with requirements of ANSI Standard Z358.1-2009: American National Standard for Emergency Eyewash and Shower Equipment

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- b) All emergency plumbing fixtures shall be accessible to persons with disabilities in compliance with the requirements of the federal Americans with Disabilities Act (ADA), ADA Accessibility Guidelines (ADAAG), and state accessibility regulations
- c) Provide tempered water to all emergency plumbing fixtures to comply with requirements of ANSI Standard Z358.1-2009: American National Standard for Emergency Eyewash and Shower Equipment.
- d) Barrier-free safety station with emergency shower actuation valve in stainless steel cabinet for recess mounting. Fixed barrier-free wall-mounted eyewash with stainless steel skirt: Water Saver Model No. SSBF670-721, or equal, with the following characteristics or modifications.
  - 1) Ceiling-mounted exposed showerhead. Nipple length shall be as required for a complete installation; verify finished ceiling height.
  - 2) Exposed piping, showerhead, nipple, and escutcheon shall be chrome-plated brass with clear epoxy coating.
  - 3) Safety shower actuating arm shall be mounted within accessible reach in a flanged, recessed-mounted 18 gauge (1.3 mm) stainless steel cabinet with No. 4 finish.
  - 4) Fixture shall be furnished with green plastic sign with graphic symbol for safety shower/eyewash.
- e) Provide wall-mounted alarm horn with weather proof flow switch and standby power source at every emergency shower location to sound when the safety shower is activated. Provide additional contacts for wiring to a remote monitoring system at the USC Department of Public Safety.
  - 1) Preferably the horn-strobe shall not be adjacent to the shower/eyewash, but shall be located in the corridor adjacent to the entrance lab in which the shower is located. The horn strobe shall be clearly signed to indicate its function and that DPS should be called if the alarm is sounding.
  - 2) If the horn is located adjacent to the shower, it shall be mutable by user, and mute button shall be clearly signed and easily accessible. (This is to prevent hearing damage to users of showers/eyewashes, and to avoid interfering with communication, emergency phone calls, etc.)
- f) Consideration will be given to flip-down eye wash unit where clearance is a concern.
- g) All eye wash units to be connected to drains to facilitate weekly activation as required by ANSI standards.
- h) Dual-purpose eye wash/drench hose unit with dual gentle spray outlet heads and squeeze handle/valve with locking clip are not acceptable as certified eye wash units.
- i) In certain high-hazard labs, it may be advisable to install a drench hose in addition to a shower/eyewash; however, under no circumstances may a drench hose be installed in lieu of a required shower/eyewash. (A drench hose is merely a backup to the shower/eyewash, to afford lab personnel more options in responding to specific emergencies.)

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

- 1. Work in this section requires close coordination with Work specified In Divisions
  - a) 11 5310 – Laboratory Casework

## **FACILITY DESIGN GUIDELINES**

- b) 22 0000 - Plumbing
  - c) 23 0000 - Mechanical
  - d) 26 0000 - Electrical
2. Work in this section requires close coordination with Owner furnished components and equipment.

### **5. EVALUATION or COMMISSIONING**

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
[None]
- B. Documentation required:
- 1. Factory test results
  - 2. Certification of lead-free fixtures

**END OF DOCUMENT**

# FACILITY DESIGN GUIDELINES

## 11 5350 LABORATORY EQUIPMENT

### 1. OVERVIEW

- A. Purpose – USC preferences, requirements and considerations for Contractor Furnished and Installed laboratory equipment are outlined in this document.
- B. For other related requirements, refer to Sections 115310–Casework, 115343–Fittings & Fixtures, 230000-Mechanical, 220000-Plumbing and 260000-Electrical.
- C. The following table summarizes the types of particular requirements identified within this section:

	Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
Freestanding laboratory glassware washing unit with complete cabinet enclosure		X		
Freestanding laboratory sterilizer (autoclave) unit with complete cabinet enclosure		X		
Prevacuum type sterilizer		X		
Extended Warrantees	X			

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Schematic Design: All Laboratory Equipment shall be identified on the final schematic Design Laboratory fit-out drawings. Equipment shall be described in detail sufficient to develop appropriate layouts and cost estimates. Equipment shall be identified as:
      - 1) Contractor Furnished, Contractor Installed
      - 2) Owner Furnished, Contractor Installed

## FACILITY DESIGN GUIDELINES

- 3) Owner Furnished, Owner Installed
  - b) Design Development: All Contractor Furnished, Contractor Installed Laboratory Equipment shall be identified on the final Design Development Drawings and specification in sufficient detail to coordinate slab depressions, verify clearances and utility requirements.
  - c) Construction Documents: All Contractor Furnished, Contractor Installed Laboratory Equipment shall be identified on the final Construction Documents in sufficient detail to competitively bid and coordinate installation with detailed and specific features.
2. Laboratory Equipment:
- a) Laboratory equipment furnished by the contractor as part of the building construction contract includes:
    - 1) Laboratory Glassware Washers (washer/dryer combination)
    - 2) Laboratory Sterilizers (autoclaves)
    - 3) Other laboratory equipment may be identified as contractor furnished, contractor installed for inclusion in the design and construction documents.

### 3. PRODUCT REQUIREMENTS

#### A. Laboratory Glassware Washers

- 1. Manufacturers:
  - a) Preferred: Glassware Washers may be provided by the following manufacturers. All products for a complete installation shall be provided by a single manufacturer.
    - 1) Steris Corporation, <http://www.steris.com>
    - 2) Hotpack Corporation, SP Scientific, <http://www.spscientific.com/Companies/Hotpack.aspx>.
    - 3) Lancer USA, <http://www.lancer.com>.
    - 4) Getinge USA, Inc., <http://www.getingeusa.com>
    - 5) Miele Professional, <http://www.miele-pro.com>.
- 2. Component Characteristics:
  - a) Microprocessor-controlled laboratory glassware washer with purified water rinsing and with at least 10 automatic wash programs, capable of accepting optional inserts such as open baskets and spindles/injectors for open or injection cleaning of laboratory glassware on multiple rack levels. Consideration should be given to integral drying capabilities.
  - b) Unit shall carry an ETL mark signifying certification to UL Standard 61010-1 and/or CAN/CSA-C22.2 No. 61010-1.
  - c) Utilize building steam when available. If building steam is not available include integral electric water heating.
  - d) Minimum chamber dimensions shall be 21¼ inches wide x 25½ inches high x 24¼ inches deep. Minimum chamber volume shall be 8.06 cubic feet. Maximum overall dimensions shall be 55 inches wide x 80¾ inches high x 36¼ inches deep.
  - e) Freestanding full cabinet enclosure, fully insulated unit with a single vertical sliding door with full view window is preferred. Consideration should be given to conditions that would require a recessed configuration.

## FACILITY DESIGN GUIDELINES

- f) Wash water temperature: Unit shall be capable of attaining a wash temperature of 203°F (95°C).
  - g) Final rinse temperature: Unit shall be capable of attaining a final purified water rinse temperature of 203°F (95°C).
  - h) Drying system: HEPA-filtered forced-air drying system which dries both the chamber and also dries glassware through the spindles/injectors. Unit shall be vented to the building exhaust system to remove vapors from the drying cycle.
3. Options and Accessories:
- a) Work with University representatives to identify all required options and accessories required for glassware washer (/dryer) units.
- B. Laboratory Sterilizers (Autoclaves)
- 1. Manufacturers:
    - a) Preferred: Sterilizers (autoclaves) may be provided by the following manufacturers. All products for a complete installation shall be provided by a single manufacturer.
      - 1) Beta Star Life Science Equipment of R-V Industries, Inc., <http://www.rvii.com>.
      - 2) Getinge USA, Inc., <http://www.getingeusa.com>.
      - 3) Primus Sterilizer Co., Inc., <http://www.primus-sterilizer.com>.
      - 4) Steris Corporation, <http://www.steris.com>.
      - 5) Consolidated Sterilizer Systems, <http://www.consteril.com>
  - 2. Component Characteristics:
    - a) Work with University representatives to determine chamber size for sterilizers. Preferred default chamber is medium sized 24" x 36" x 36". When sterilizers are paired in a common facility consideration should be given to on large unit and one or more small or medium sized units.
    - b) Freestanding, single door, fully enclosed double wall, jacketed and insulated unit is preferred. Consideration shall be given to configurations which may be required through the wall or double ended pass-through models. Special consideration shall be given to bio-seal conditions required by containment pass-through sterilizers.
    - c) Sterilizers shall be Prevacuum type as the preferred default. Prevacuum process shall be designed for fast, efficient sterilization of porous, heat- and moisture-stable materials, sterilization of liquids and media in borosilicate glass containers with vented closures, and decontamination of supplies after laboratory procedures.
    - d) Utilize building steam when available. If building steam is not available include integral electric carbon steel steam generator supplied with industrial water. Consideration shall be given to need for clean steam and an integral indirect steam-to-steam stainless steel clean steam generator supplied with building steam and purified water.
    - e) Sterilizer shall allow for general purpose steam sterilization at temperatures ranging from 105 – 135°C (221 – 275°F). The sterilization and drying time range shall be 0-99 minutes. The unit shall be capable of twelve (12) stand programs.
    - f) Sterilizer control system shall monitor, control, display, and record all process parameters. The control system shall include a PLC controller, touch-screen operator interface control panel, printer, audible alert, and emergency manual off (EMO) safety switch.



## **FACILITY DESIGN GUIDELINES**

3. Options and Accessories:
  - a) Work with University representatives to identify all required options and accessories required for laboratory sterilizers.

### **4. INSTALLATION REQUIREMENTS**

- A. Required:
  1. Work in this Section requires close coordination with Work specified in Divisions:
    - a) Mechanical 23 0000
    - b) Plumbing 22 0000
    - c) Electrical 26 0000
  2. Work in this Section requires close coordination with Owner furnished components and equipment.

### **5. EVALUATION or COMMISSIONING**

- A. Standards: Units shall conform to the applicable requirements of the following:
  1. Underwriters Laboratories (UL).
  2. International Plumbing Code.
  3. National Electric Code.
  4. ASME Code, Section VIII, Division 1 for unfired pressure vessels.
- B. Extended Warrantees: All products for complete installation of Sterilizers and Glassware Washers will be warranted to be free from defects in materials and workmanship for a minimum period of five years following substantial completion. The manufacturer/ dealer/ subcontractor shall repair or replace any products (or parts thereof) that are found to be defective. Replacement will include any parts, labor, shipping, and travel expenses involved.

**END OF DOCUMENT**

# FACILITY DESIGN GUIDELINES

## 11 6150 CONTROLLED ENVIRONMENT ROOMS

### 1. OVERVIEW

- A. Purpose – USC preferences, requirements and considerations for Controlled Environment Rooms (CER's) are outlined in this document.
- B. For other related requirements, refer to Sections 03 3000-Concrete, 11 5310–Casework, 11 5343–Fittings & Fixtures, 23 0000-Mechanical, 22 0000-Plumbing and 26 0000-Electrical, 09 6000-Flooring, 09 5000-Ceilings.
- C. The following table summarizes the types of particular requirements identified within this section:

	Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
Insulated floor panels – 2” minimum thickness	X			
Recessed slab for floor panel flush with adjacent finish floor	X			
Ramps in new construction			X	
Water Cooled Condenser		X		
Full Glass Door		X		
Standby power	X			

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Schematic Design: All Controlled Environment Rooms shall be identified on the final schematic Design laboratory fit-out drawings. Temperature and humidity ranges shall be described in detail sufficient to develop preliminary construction estimates.
      - i. If it is determined by consultation with the user and with EH&S that flammable materials (e.g. solvents), asphyxiants (e.g. liquid nitrogen,

## FACILITY DESIGN GUIDELINES

dry ice, nitrogen gas, etc.), or other airborne hazards will be used in the Controlled Environment Room, and if the user is not able to eliminate the hazard from their work, the design specification shall include appropriate safety controls including open-circuit ventilation with adequate air changes, gas alarms, local exhaust ventilation, etc.

- b) Design Development: All Controlled Environment Rooms shall be identified on the final Design Development Drawings and specification in sufficient detail to coordinate slab depressions. Final Design Development Drawings shall identify the type of cooling for the condensing units and locate those condensing units on the plans.
  - c) Construction Documents: All Controlled Environment Rooms shall be identified on the final Construction Documents in sufficient detail to competitively bid and install the CER's with detailed and specific features.
2. Preferred:
- a) Teaching Laboratories: Controlled Environment Rooms are rarely used in undergraduate teaching laboratory facilities except to support prep / storage and specific unique functions. CER's proposed for storage only should be challenged and alternative conventional refrigerators or incubators should be considered.
  - b) Research Laboratories: Controlled Environment Rooms supporting research laboratories should serve more than storage only needs. Working CER's with benching and sinks should be designed for occupancy and flexibility. Consideration should be given to reach-in storage units for research functions that are proposed as the basis of need for CER's.
- B. Accessibility Considerations for Controlled Environment Rooms:
- 1. All code requirements for accessibility shall be met and approved by the authority having jurisdiction.
  - 2. Teaching Laboratory Application: Controlled Environment Rooms are rarely occupied as part of a student learning experience. As such CER's may not fall under the requirements of accessibility within. Review the need for a non-student occupied CER to be made accessible with the governing authorities.
  - 3. Research Laboratory Application: Where Controlled Environment Rooms support research laboratories for which accessibility is required or being provided at least one (or 5%) shall be made accessible. Accessibility to and within a CER includes access, turn around space, accessible bench space and accessible sink if provided. Flush floors are required for accessible Controlled environment rooms. Short ramps are not allowed.

### 3. PRODUCT REQUIREMENTS

- A. Controlled Environment Rooms
- 1. Manufacturers:
    - a) Preferred: Controlled Environment Rooms complete with all necessary equipment, controls, accessories, and hardware may be provided by the following manufacturers. All products for a complete installation shall be provided by a single manufacturer.
      - i. Environmental Growth Chambers (EGC), <http://www.egc.com>.
      - ii. Controlled Environments Inc. (Convion), <http://www.convion.com>.
      - iii. Harris Environmental Systems, <http://harrisenv.com>
      - iv. Insulated Structures, <https://www.insulatedstructures.com>

## FACILITY DESIGN GUIDELINES

- v. TriMark R.W. Smith & Co., <https://www.rwsmithco.com>
- vi. Climate Technologies, <https://www.climatetechnologies.com>

### 2. Component Characteristics:

- a) The design and installation of Controlled Environment Rooms includes locating condensing units which may be remote and coordinating the pathway to the CER within the piping limits set out by the manufacturers.
- b) All components of Controlled Environment Rooms shall be served by standby power from an emergency generator to avoid loss of temperature and humidity control in the event of a power outage.
- c) Controlled Environment Rooms shall be of modular, “sandwich panel”, construction. Each panel shall consist of interior and exterior metal skins with a solid core of insulation and shall incorporate an integral mechanical method of fastening and sealing the joints to provide a vapor tight seal. Construction shall allow disassembly for possible relocation or expansion at a later date. Each controlled environment room, unless otherwise specified, shall be complete with all necessary environmental conditioning controls, heating, refrigeration and air conditioning systems, lighting systems and all necessary mechanical and electrical components to provide the specific environmental conditions identified.
- d) Room shall be entirely waterproof, pre-wired with all receptacles, lighting, and 120V and low voltage control circuits installed. Electrical shall be provided in flush-mounted, vapor-proof j-boxes and covers foamed into the insulated wall panel. All conduit shall be in wall panels. All plumbing shall be hidden and all penetrations and back boxes foamed into panels and sealed.
- e) Floor panels of 2” or 4” capable of supporting uniformly distributed load of up to 500lbs/sf shall be included in all CER designs.
- f) Floor panels shall be covered with a seamless, non-absorbent, slip resistant vinyl floor covering. Material shall have temperature, flexibility and dimensional stability from +60°C to -20°C
- g) Doors: Full Glass Doors with sealed triple pane safety glass are preferred. 3' x 7' self-closing doors with frameless appearing exterior door face. Door design shall allow for required interior temperatures with clear condensate free surfaces. Push activated latch release shall be provided on the inside of the door. Door shall be capable of reversing swing, left or right, in the field.
- h) A diffusion grating suspended ceiling with a grid of open cells shall be installed below the controlled environment room roof panels in order to provide a positive pressure air plenum extending across the entire room ceiling. Consideration will be given to eliminating the suspended ceiling for functional reasons.
- i) Temperature Control: Room temperature shall be maintained within  $\pm 1.0^{\circ}\text{C}$  of the room temperature setpoint. The sensitivity, display, setpoint, and response of the temperature controls shall be  $\pm 0.2^{\circ}\text{C}$  resolution or less.
- j) Temperature Gradient: Temperature gradient from floor to ceiling shall not exceed  $1.0^{\circ}\text{C}$ .
- k) Temperature Uniformity: Temperature uniformity shall be  $\pm 0.5^{\circ}\text{C}$ . This refers to the temperature as measured within the room volume that is 12 inches (305 mm) from the walls, doors, ceiling and floors.
- l) When Humidity control is specifically required humidity shall be maintained at a level to avoid condensation on room surfaces under operating

## FACILITY DESIGN GUIDELINES

- conditions. Room relative humidity shall be maintained within  $\pm 5\%$  of the room humidity setpoint. The sensitivity, display, setpoint, and response of the humidity controls shall be at 1.0% RH resolution or less.
- m) Microprocessor based touchscreen controller with fixed programmed logic shall be provided for temperature control (and humidity control when required) in a surface mounted control console located on the latch side of the Controlled Environment Room exterior. Controller shall include real-time trending of temperature parameters and setpoints through touchscreen display with paperless recording of operating data.
  - n) An alarm system shall be provided for temperature limits and compressor failure. Rooms with humidity control shall be provided with similar alarms for relative humidity limits. Alarm shall sound locally and include contacts for relay to remote monitoring location. Alarms shall be served by standby power from the emergency generator.
  - o) Personnel Emergency Alarm shall be provided with reset type, electrically powered personnel emergency alarm system. The system shall consist of an actuator within the room and audible and visual alarms affixed to the front exterior of the room.
  - p) The refrigeration system shall use refrigerants acceptable to the Authority having jurisdiction. Utilize non-ozone depleting refrigerants R-134a, R-404A, or approved equal; CFC type refrigerant shall not be allowed.
  - q) The refrigeration system shall be designed and furnished in such a manner as to allow the motor compressor to operate continuously with a modulating bypass system to maintain specified temperature ranges.
  - r) Incorporate an automatic defrost system for any room operating below  $5^{\circ}\text{C}$ .
  - s) All refrigeration piping required shall be furnished and installed by the controlled temperature room manufacturer.
  - t) Water cooled condensing units located on top of the Controlled Environment Room within the attic space are preferred where chilled process cooling water supply and return are available. Consideration will be given to air cooled condensing units remotely located within manufacturer distance limits on the building roof.

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Work in this Section requires close coordination with Work specified in Divisions:
    - a) Concrete Slabs 03 3000
    - b) Ceilings 09 5000
    - c) Flooring 09 6000
    - d) Mechanical 23 0000
    - e) Plumbing 22 0000
    - f) Electrical 26 0000
  - 2. Work in this Section requires close coordination with Owner furnished components and equipment.

### 5. EVALUATION or COMMISSIONING

- A. Control Temperature Set-point: Measure and record room temperature during a continuous 24 hour test period. The room shall maintain temperature setpoint with  $\pm 1.0^{\circ}\text{C}$ .

## FACILITY DESIGN GUIDELINES

- B. Temperature Gradient: Measure and record room temperature gradient during a continuous 24 hour test period. Verify that the maximum temperature gradient from floor to ceiling does not exceed 1.0°C.
- C. Temperature Uniformity: Measure and record temperature uniformity during a continuous 24 hour test period as described previously. Temperature uniformity shall be  $\pm 0.5^{\circ}\text{C}$ .
- D. Control Humidity Set-point (where applicable): Measure and record room humidity during a continuous 24 hour test period. The room shall maintain humidity setpoint within  $\pm 5\%$  RH.
- E. Recovery Test: Perform recovery test as described previously. All rooms, except freezers, shall recover within five (5) minutes.
- F. Internal Load Test: Each room shall maintain temperature within  $\pm 1.0^{\circ}\text{C}$  of setpoint when operating with the specified number of people, make up ventilation air, and internal heat gain from lighting and equipment.
- G. Documentation: Submit certified written reports of all tests. Reports shall indicate testing procedures followed, instruments used, and tabulation of results.
- H. Witnessing of Tests: Owner's representative shall be given the option of witnessing and confirming test results. Notify Owner's representative in writing at least 10 days prior to conducting tests.
- I. Complete control panel assembly shall be tested and certified by an independent, nationally recognized testing laboratory to be in accordance with NFPA 70 and UL 508A as required by the National Electric Code.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 12 0000 FURNISHINGS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements for window treatments and entrance mats and frames are described in this Section.
- B. The following table summarizes the types of particular requirements identified within this Section:

Requirements Listed	Preferences Listed	Disallowed Items Listed	Items Requiring Commissioning/ Testing
X	X		

### 2. PROCEDURAL REQUIREMENTS

- A. Design Considerations for Roller Shades:
1. Required: Motorized units, in lieu of manually-operated ones, will be determined on a per-project basis.

### 3. PRODUCT REQUIREMENTS

- A. Roller Shade Manufacturers:
1. Preferred:
    - a) Draper Inc.
    - b) Hunter Douglas Contract.
    - c) Lutron Electronics Co., Inc.
    - d) MechoShade Systems, Inc.
    - e) Nysan Solar Control Inc.; Hunter Douglas Company.
    - f) Silent Gliss USA, Inc.
- B. Roller Shade Operation:
1. Required: Manually-operated units.
  2. Preferred: Motorized units may be used when space and position make manually-operated units impractical.
- C. Vertical Louver Blind Manufacturers:
1. Preferred:
    - a) Hunter Douglas Contract.
    - b) Levolor Contract; a Newell Rubbermaid company.
- D. Entrance Mats and Frames:
1. Locations:
    - a) Required: All USC campus buildings.

## **USC DESIGN GUIDELINES**

- 4. INSTALLATION REQUIREMENTS – Not Used**
- 5. EVALUATION or COMMISSIONING – Not Used**

**END OF DOCUMENT**



# USC DESIGN GUIDELINES

## 12 9313 BICYCLE RACKS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X			

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. For purpose of this guideline, this section pertains to bicycle racks.
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Bicycle Racks:
  - 1. Manufacturers:
    - a) Required:
      - 1) Park-A-Bike, Sacramento, CA 800-481-8524
    - b) Preferred: N/A
    - c) Disallowed: All others.
  - 2. Component Characteristics (Required):
    - a) Varsity Bike Dock
    - b) Model number DV211 surface mounted
    - c) Finish: Powdercoat Black
- B. Anchors
  - 1. Required:
    - a) Red Head Drop-In Anchors 3/8" for concrete floor applications
- C. Bolts
  - 1. Required:
    - a) Everbilt Coarse Thread, 3/8 in-16x1 inch, zinc plated hex bolts

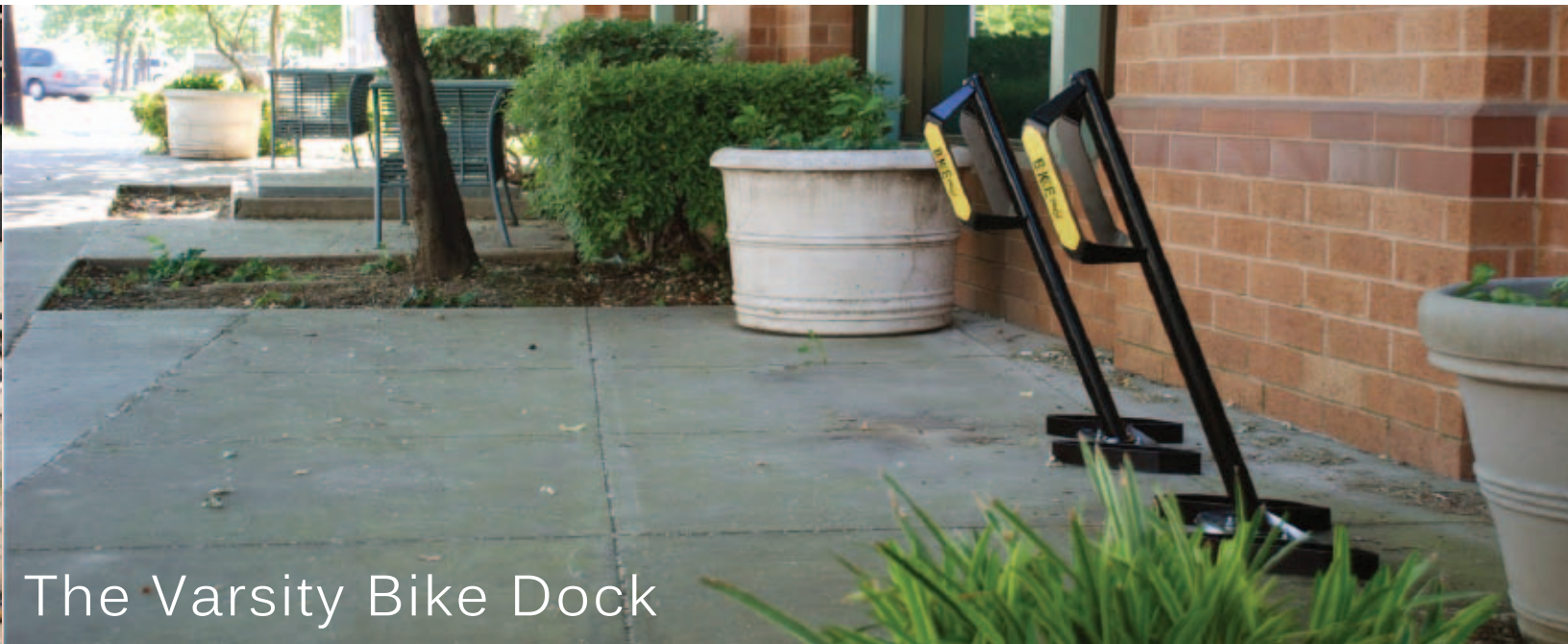
### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. 1/2" drill bit required for drop-in anchors

## **USC DESIGN GUIDELINES**

2. 1-5/8" minimum embedment for drop-in anchors
3. Dual bolt system for single stand bike racks. Each bike rack requires (2) each anchor and (2) bolts
4. Hole must be pre-drilled and anchor set into hole, then bolt is placed over base of bike rack and bolted to the ground.

### **5. EVALUATION or COMMISSIONING – NOT USED**



The Varsity Bike Dock



Custom branding



High density



Custom QR tags for cycling info



Wheel troughs to contain the wheel

At Park a Bike we believe a bike rack should be more than just a bent piece of metal that you lean your bike against. It can be safe, secure, it can educate, and we have built just that.

# specs

## MATERIALS

ASTM A36 Steel for all structural steel plate (standard)

ASTM A53 Steel for all Pipe (standard)

## FINISH

### Galvanized

A zinc oxide coating protects from elements that can lead to oxidation, corrosion and rust that can cause the eventual weakening of the steel.

### Black Powder Coat

Final Coat- Polyester based Powder Coating – this offers a hard shell finish to the product to protect the metal substrate from oxidizing. Our finishes withstand harsh conditions with a strong polyester UV-stable coating with superior salt spray protection.

## MOUNTING

### Surface Mount- Varsity Bike Dock DV211

Each DV211 mounts with two  $\frac{3}{8}$ " x  $4\frac{1}{2}$ " wedge sleeve anchors.

### In-ground Mount- Varsity Bike Dock DV212

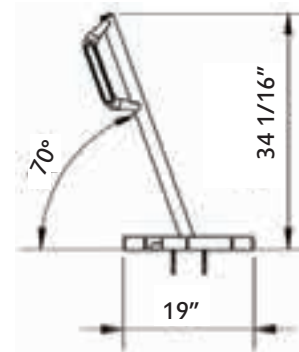
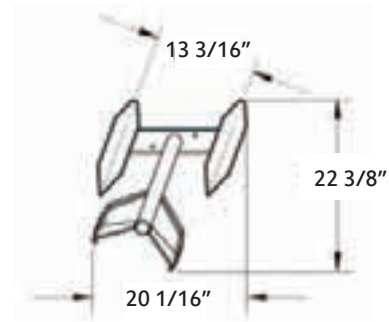
Each DV212 is secured to the below ground mounting base using two  $\frac{1}{2}$ " carriage bolts.

### Rail Mount

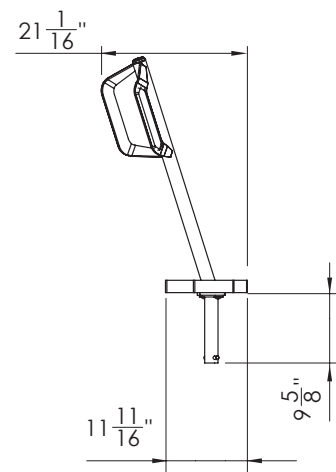
Varsity Bike Docks can be welded to a rail for special requests.

## SPACING

Units can be installed together with a 24" or 18" aisle for high density bike parking. The units are modular so they can be installed as angled or perpendicular bike parking. Sample layouts can be downloaded from our website.



surface mount  
DV211



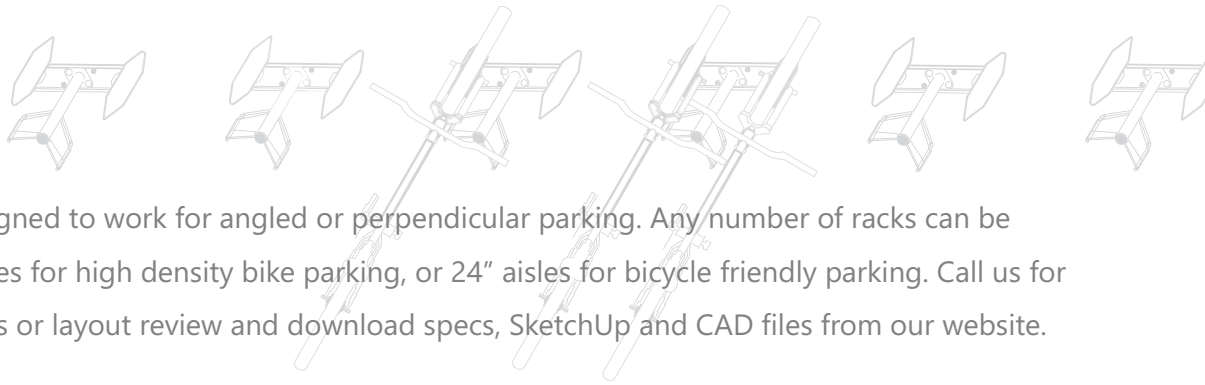
in-ground mount  
DV212

# features

- Each individual dock secures two bikes
- U-lock and cable lock compatible
- 3 contact points with a U-lock
- 2 points of contact with the bike
- Single unit replacability
- No wheel bending
- Case hardened locking loop for added theft protection
- Built for maximum space efficiency
- Smart Guards, the first of their kind that uses an injection molded Polyurethane that coats and protects the bike finish when leaning the bike against the locking loop
- Buddy locking system allows for two bikes to be locked up simultaneously with one cable lock
- Patented angle bike cradles capture your wheel and also allows for a tighter fit with minimal contact
- Specs, SketchUp, and CAD files are available for download on our website.



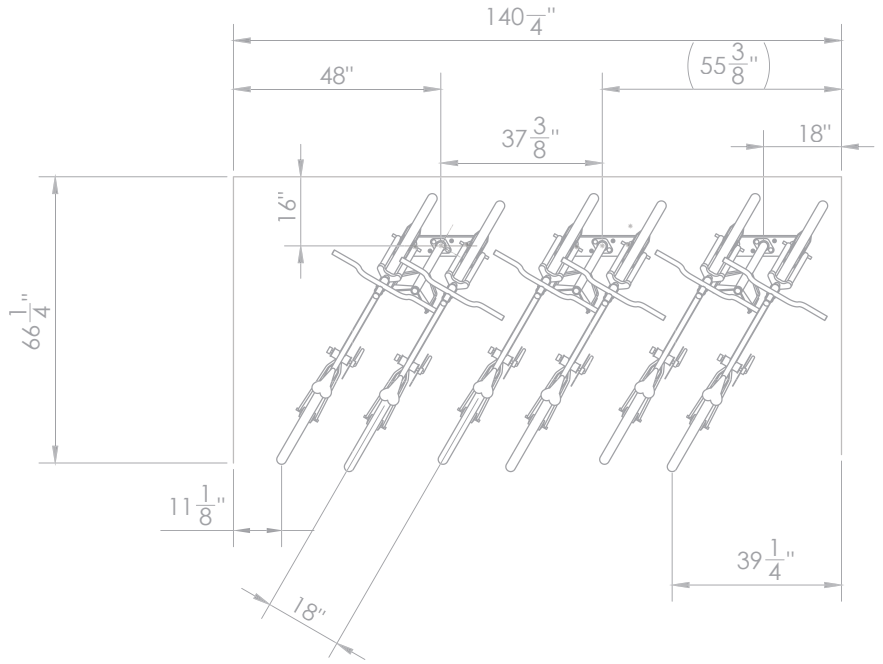
# planning



The Varsity Bike Dock™ is designed to work for angled or perpendicular parking. Any number of racks can be installed together with 18" aisles for high density bike parking, or 24" aisles for bicycle friendly parking. Call us for help with site planning, layouts or layout review and download specs, SketchUp and CAD files from our website.

## Angled Parking

- Our bike docks are designed to work as either a right facing or left facing dock
- Angled wheel troughs angle the bikes for space saving, high density bike parking
- We recommend allowing 24" separation between aisles, but our docks allow for up to 18".
- More sample layouts can be downloaded from our website



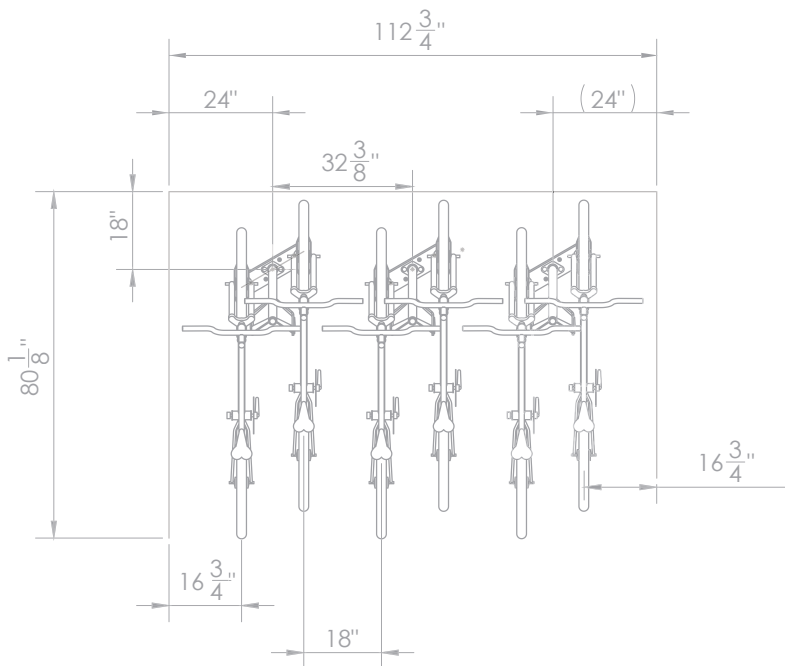
Right facing



Left facing

## Perpendicular Parking

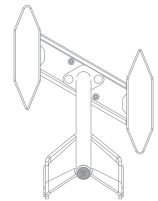
- The angled wheel troughs will offset handlebars which prevents handlebar and chain conflicts between bikes
- Docks can be reversed so either the right wheel or left wheel is forward
- More sample layouts can be downloaded from the downloads section of our website



Right wheel forward



Left wheel forward



# USC DESIGN GUIDELINES

END OF DOCUMENT



# USC DESIGN GUIDELINES

## 12 9323 TRASH AND LITTER RECEPTORS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X			

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. For purpose of this guideline, this section pertains to Exterior Multi-Stream Waste Bins
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Exterior Multi-Stream Bins:
  - 1. Manufacturers:
    - a) Required:
      - 1) Midpoint International, Clean River Recycling Solutions, 888-646-4246
    - b) Preferred: N/A
    - c) Disallowed: All others.
  - 2. Component Characteristics (Required):
    - a) Series: SP-USC-XV51-3-R1 FOUR, THREE, OR TWO STREAM
    - b) Model number XV51-3-R1
    - c) Color: (Black Frame), (Black, Grey Panels front, Black Panels back and sides)
    - d) Text: LANDFILL/MIXED RECYCLING/ LIQUID WASTE/COMPOST

## **USC DESIGN GUIDELINES**

### **4. INSTALLATION REQUIREMENTS**

#### **A. Required:**

1. Install per manufacturer requirements

### **5. EVALUATION or COMMISSIONING – NOT USED**

**END OF DOCUMENT**



## SP-USC-XV51-3-R1

This sturdy container is designed for use in high traffic areas. It features front deposit openings and front service doors with rigid liners for easy servicing. The slanted roof design avoids buildup of dirt and debris.

## Features

- Rigid liners included.
- Front service, front deposit.
- Ideal for malls, parks and recreational facilities and entranceways.
- Drainage holes inside prevent buildup of liquid from spills, leaks or weather.
- Includes high visibility quick change stream labels.

TRASH AND LITTER RECEPTORS  
REVISION 2023.01 01-30-2023

## Material

Made from Recycled HDPE

## Colors



# USC DESIGN GUIDELINES

## 12 9343.13 SITE SEATING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X			

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. For purpose of this guideline, this section pertains to site seating, aka benches.
- B. Quality Assurance requirements beyond standard 1 year warranty: 10 year warranty

### 3. PRODUCT REQUIREMENTS

- A. Bench:
  - 1. Manufacturers:
    - a) Required:
      - 1) Victor Stanley Inc, Dunkirk, Maryland 800-368-2573
    - b) Preferred: N/A
    - c) Disallowed: All others.
  - 2. Component Characteristics (Required):
    - a) Series: Classic Series
    - b) Model number CS-138
    - c) Finish: Powdercoat Tavern Green
    - d) Description: Bench with ductile iron end frames. Standard 6' length
- B. Anchors
  - 1. Required:
    - a) Red Head Drop-In Anchors 3/8" for concrete floor applications
- C. Bolts
  - 1. Required:
    - a) Everbilt Coarse Thread, 3/8 in-16x1 inch, zinc plated hex bolts

## USC DESIGN GUIDELINES

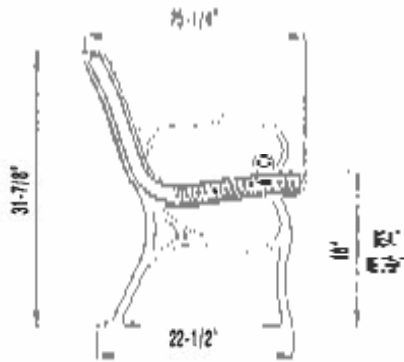
### 4. INSTALLATION REQUIREMENTS

#### A. Required:

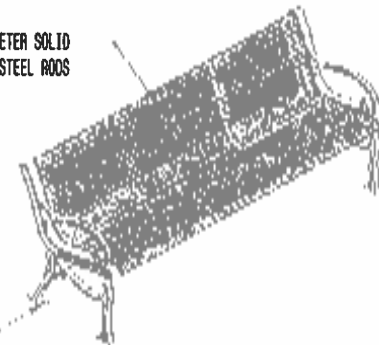
1. 1/2" drill bit required for drop-in anchors
2. 1-5/8" minimum embedment for drop-in anchors
3. Dual bolt system for bench.
4. Hole must be pre-drilled and anchor set into hole, then bolt is placed over base of bench and bolted to the ground.

### 5. EVALUATION or COMMISSIONING – NOT USED

\* ALL DIMENSIONS ARE IN INCHES \*

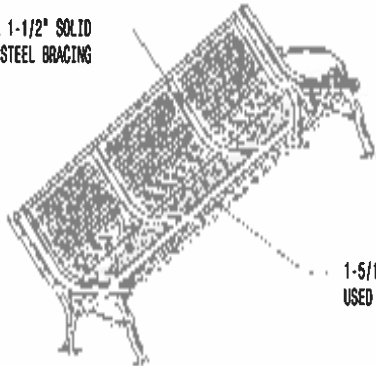


5/8" DIAMETER SOLID HORIZONTAL STEEL RODS

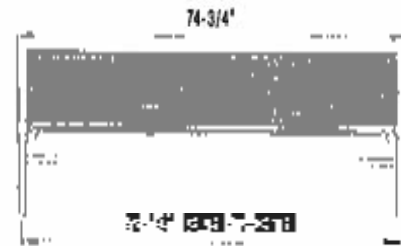


CLEARANCE FOR 3/8" ANCHOR BOLTS

1/4" x 1-1/2" SOLID STEEL BRACING



1-5/16" TUBULAR STEEL RING USED FOR ADDITIONAL SUPPORT



200# TO 250# LOADS ARE APPROXIMATE  
 LOADINGS IN USE ARE BASED FROM EFFICIENT USE OF COLUMN

**INCLUDES:**  
 PAPER COATING

- 1 SANDWICH CLIP, 2 TUBULAR RING CLIP,
- 200# CLIP (INCLUDING THE 100# CLIP)

**ATTACHMENT & OTHER FEATURES**

- 1" X 1/2" AVAILABLE WITH OPTIONAL ANCHORS
- LENGTH
- STANDARD 4
- STANDARD 6 (160# LOAD)

**NOTES:**

1. MODEL FOR CASTING CONCRETE TO BE PERMANENTLY MARKED BEHIND.
2. DIMENSIONS NOT TO SCALE. SEE FOR SCALE DRAWING.
3. ALL EXPOSED METAL COMPONENTS ARE STEEL. WELDED, FUSED, FERRITIC, PREHEATED AND ELECTROSTATICALLY POWDER-COATED WITH 100% POLYESTER POWDER COATING. PRODUCTS ARE FULLY GROUND AND PREHEATED, PREHEATED AND GROUNDABLE TO FULL SPECIFICATIONS AND ALL COATING FULL COATING. PARTS ARE FULLY COATED TO MEETING MANUFACTURER'S SPECIFICATIONS. THE DEGREE OF THE RESULTING FINISH VARIATION IS 4 MILS. (100-200 MICRONS).
4. IT IS NOT RECOMMENDED TO LOCATE ANCHOR BOLTS UNTIL THEY ARE IN PLACE. THIS EXCEPT STABILITY, THE PRODUCT MUST BE PERMANENTLY AFFIXED TO BE GROUND. CONSULT YOUR LOCAL CODES FOR REGULATIONS.
5. ANCHOR BOLTS ARE PROVIDED BY THE USER, ETC.
6. FOR BEST AND MOST DURABLE FINISH, PRE-PAID GALVANIZING BEFORE POWDER COATING IS AVAILABLE. ANCHOR GALVANIZING IS PERFORMED FOR VICTOR STANLEY, INC. BY AN EXPERIENCED QUALIFIED FIRM IN WHICH PRODUCTS ARE SHIPPED FOR GALVANIZING. ANCHOR GALVANIZING PROCESSES AN ACCESSIBLE PRE-TREATMENT AND IMMERSION IN A BATH OF CHLORIDE ZINC SOLUTION AND AN ANODIC BATH. THE RESULTING SURFACE IS RESISTANT TO RUST AND HAS SOME IMPROVED RESISTANCE FROM THE BONDING OF THE COATING TO THE STEEL SURFACE. AS A RESULT, THE POWDER COATING SURFACE FINISH OVER THE GALVANIZED SURFACE HAS EXCELLENT ADHESION, DURABILITY, AND MAY NOT BE AS DURABLE AS THE SANDWICH CLIP. THIS FACTOR MAY INCREASE THE COST OF MANUFACTURING. CONTACT MANUFACTURER FOR DETAILS.
7. ALL SPECIFICATIONS ARE SUBJECT TO CHANGE. CONTACT MANUFACTURER FOR DETAILS.
8. THIS PRODUCT IS SHIPPED FULLY ASSEMBLED.



**CS-138**  
**CASCOSTEEL**

800 368 2573  
 WWW.VICTORSTANLEY.COM



Create a timeless moment.™



## CS-138

This horizontal solid steel rod bench is one of the most durable, strong and distinctive benches in the Classic collection. Backless bench available as Model CS-158.

4 or 6 ft (1.2 or 1.8 m) lengths. Horizontal steel rods. Surface mount.

### STANDARD

All fabricated metal components are steel shotblasted, etched, phosphatized, preheated and electrostatically powder-coated with TGIC polyester powder coatings.

**Victor Stanley castings are genuine DUCTILE-IRON and carry our 10-year warranty against breakage.**

### OPTIONS

Intermediate armrests (bolt-on) for 4 or 6 ft (1.2 or 1.8 m) length.

RETURN TO STANDARD VIEW

## MATERIAL

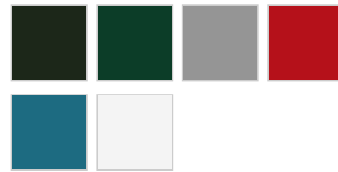
**Ductile-Iron Casting**

**Solid Steel Rod**

## COLORS

**Standard**





**Optional RAL**



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1.800.368.2573 (USA + Canada) TEL 301.855.8300

Most Victor Stanley benches are ADA compliant. Member of the ASLA. Member of the USGBC.



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Corridor	Litter Receptacles		E-News Sign-Up	
Cycle Sentry™	Planters		Follow Us, Facebook   Twitter	
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GreenSites				
Homestead				
Ironsites®				
Parsons				
Perenne				



# USC DESIGN GUIDELINES

END OF DOCUMENT

# USC DESIGN GUIDELINES

## 13 2000 SPECIAL PURPOSE ROOMS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are described in this document for the following:
1. Lactation Rooms
- B. The following table summarizes the types of particular requirements identified within this Section:

Requirements Listed	Preferences Listed	Disallowed Items Listed	Item Requiring Commissioning/ Testing
X	X		

### 2. PROCEDURAL REQUIREMENTS, GENERAL

- A. Lactation Room, when added as part of a project, shall include the following elements:
1. Chair suitable for comfort which may include reclining function
  2. Side table
  3. Sink with counter space including soap dispenser and paper towel dispenser
  4. Door lock indicating room is occupied
    - a) Electronic lock when required
  5. Duplex outlets, at minimum two in room – one at counter and one by chair location.

### 3. PRODUCT REQUIREMENT – NOT USED

### 4. INSTALLATION REQUIREMENTS – NOT USED

### 5. EVALUATION or COMMISSIONING – NOT USED

END OF DOCUMENT

# USC DESIGN GUIDELINES

## 13 4800 ACOUSTICS AND VIBRATION REQUIREMENTS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document. This section establishes USC's basic Acoustics and Vibration Design performance/expectations/goals/guidelines applicable to various types of campus buildings including; Academic Classrooms, Teaching Laboratories, Research Laboratories, Students Housings, Performing Visual/Arts and Music buildings, Medical facilities, and others.

## USC DESIGN GUIDELINES

### 2. ARCHITECTURAL ACOUSTICS REQUIREMENTS

#### A. Building Interior Sound Isolations -

1. Partition walls and floor/ceiling assemblies STC rating (Sound Transmission Class) requirements per ASTM E366 Standards:

	Office	Conference Room	Classroom	Lecture/Seminar	Teaching Laboratory	Student Dorms (Bedrooms)	Individual Study Room	Library (Reading Area)	Theater/Auditorium	Music Practice Room	Computer Room	Lobby	Bathroom	Corridor	Mechanical Room	Patient Rooms	Clinical Offices	Exam Rooms
Office	45	50	50	55	45	50	50	50	b	60	45	45	50	45	60	NA	50	50
Conference Room	50	50	50	55	50	50	50	50	b	a	60	50	a	60	a	NA	50	50
Classroom	50	50	45 <sup>2</sup>	55	50	a	50	NA	b	65	50	45	a	45	65	NA	50	NA
Lecture/Seminar	50	55	50	55	50	a	50	50	a	a	50	50	a	50	65	NA	55	55
Laboratory (Teaching/Research)	50	50	50	50	50	a	50	a	NA	65	45	45	a	45	55	NA	50	NA
Student Dorms (Bedrooms)	50	50	a	a	a	50	50	a	a	a	50	50	NA	50	a	NA	NA	NA
Elevator Shaft <sup>3</sup>	60	60	65	65	60	a	a	a	a	a	60	55	50	50	45	a	50	50
Mechanical/electrical Rooms	55	55	a	a	a	a	a	a	b	a	50	50	45	50	45	a	50	50
Theater/Auditorium	b	b	b	a	a	a	b	b	b	b	b	b	b	b	b	NA	NA	NA
Music Practice Room	65	65	65	65	60	a	65	65	b	60	60	60	NA	60	a	NA	NA	NA
Computer Room	45	50	50	50	50	a	a	50	b	60	45	45	50	45	55	NA	NA	NA
Lobby	45	50	45	50	45	50	50	45	b	60	45	NA	50	NA	50	45	45	50
Patient Rooms	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	45	NA	45	a	50	50	50
Clinical Offices	50	50	50	55	50	NA	NA	NA	NA	NA	NA	45	50	45	55	50	50	50
Exam Rooms	50	50	a	55	NA	NA	NA	NA	NA	NA	NA	50	50	50	55	50	50	50

*Notes:*

*a Space adjacency not recommended.*

*b Consult USC Project Manager.*

*1 All STC-rated walls are full-heights; slab-to-slab.*

*2 STC50, if classroom function includes use of sound amplifications system.*

*3 Shaft wall construction systems.*

*NA: Not Applicable*

## USC DESIGN GUIDELINES

Partition Walls STC Ratings - Examples of wall STC-rated assemblies' minimum requirements. All STC-rated wall assemblies are full-height construction, slab-to-slab:

<b>STC-Rated Construction Assemblies</b>	
<p><b>STC 45</b> – metal studs (<i>minimum 3 5/8"</i>) with two layers of 5/8" thick gypsum board (one on each side of the stud) and fiberglass sound insulation blanket (<i>minimum R13</i>) in the wall cavity. The gypsum board panels should be constructed from slab to slab with the gypsum board terminated about 1/2" from the slab on the top and bottom, the gap between the gypsum board and slab should be filled with non-hardening acoustical sealant.</p>	<p>(1) LAYER 5/8" GYPSUM BOARD EACH SIDE ACOUSTIC BATT INSULATION IN STUD CAVITY 3-5/8" MINIMUM METAL STUD</p>
<p><b>STC 50</b> – metal studs with three layers of 5/8" thick gypsum board (two on one side and one on the opposite side) and fiberglass sound insulation blanket in the wall cavity. The gypsum board panels should be constructed from slab to slab with the gypsum board terminated about 1/2" from the slab on the top and bottom, the gap between the gypsum board and slab should be filled with non-hardening acoustical sealant.</p>	<p>(2) LAYERS 5/8" GYPSUM BOARD ONE SIDE AND (1) LAYER ON THE OTHER SIDE ACOUSTIC BATT INSULATION IN STUD CAVITY 3-5/8" MINIMUM METAL STUD</p>
<p><b>STC 55</b> – metal studs with four layers of 5/8" thick gypsum board (two on each side of the stud) and fiberglass sound insulation blanket in the wall cavity. The gypsum board panels should be constructed from slab to slab with the gypsum board terminated about 1/2" from the slab on the top and bottom, the gap between the gypsum board and slab should be filled with non-hardening acoustical sealant.</p>	<p>(2) LAYERS 5/8" GYPSUM BOARD EACH SIDE ACOUSTIC BATT INSULATION IN STUD CAVITY 3-5/8" MINIMUM METAL STUD</p>
<p><b>STC 60</b> – staggered studs on minimum 6" floor plate with four layers of 5/8" thick gypsum board (two on each side of the stud) and fiberglass sound insulation blanket in the wall cavity. The gypsum board panels should be constructed from slab to slab with the gypsum board terminated about 1/2" from the slab on the top and bottom, and the gap filled with non-hardening acoustical sealant.</p>	<p>(2) LAYERS 5/8" GYPSUM BOARD EACH SIDE ACOUSTIC BATT INSULATION IN STUD CAVITY 3-5/8" METAL STUD STAGGERED</p>

## USC DESIGN GUIDELINES

<b>STC-Rated Construction Assemblies</b>	
<p><b>STC 65</b> – double studs (minimum 1” airspace between the studs) with four layers of 5/8” thick gypsum board (two on each side of the stud) and fiberglass sound insulation blanket in the wall cavity. The gypsum board panels should be constructed from slab to slab with the gypsum board terminated about 1/2” from the slab on the top and bottom, and the gap filled with non-hardening acoustical sealant.</p>	
<p><i>Notes:</i></p> <ol style="list-style-type: none"> <li>1 <i>Alternative wall constructions assemblies should be verified by the USC Project Manager.</i></li> <li>2 <i>Partition's fire ratings shall not be compromised by the partition's STC ratings.</i></li> </ol>	

2. Interior door STC rating requirements per ASTM E90 and E336 Standards:

Door Location	Sound Rating	Construction Description <sup>1</sup> (Example)
STC 50 and STC 55 wall constructions	STC 40	Standard 1 3/4” solid core timber door with sound seal/gaskets at door bottom/jamb/seals.
STC 60 and higher wall constructions	STC 50	Specially built acoustical door set including acoustic seals. Or, a double door of STC 37 ratings separated by a sound lock vestibule.
Main Mechanical Equipment Room	STC 40	Insulated metal panel door with sound seal/gaskets at door bottom/jamb/seals.
<p><i>Notes:</i></p> <ol style="list-style-type: none"> <li>1 <i>Door's fire ratings shall not be compromised by door's STC requirements.</i></li> </ol>		

## USC DESIGN GUIDELINES

### B. Room Acoustics (Reverberation Time, Ceiling NRC, etc.) Requirements:

Room Type	RT <sub>60</sub> (second)	Surface Finishes		
		Floor	Ceiling	Walls
Theater/Auditorium	a	a	a	a
Music Practice Room	0.4	F1	C1	W1
Classrooms w/ Volume <10,000 cubic feet	0.6	F1	C1	n/a
Classrooms w/Volume >10,000 cubic feet	0.7	F1	C1/C2	W1
Lecture Rooms	0.7-1.0	F1/F2	C1	W1/W2
Offices	0.7	F1	C1/C2	n/a
Conference Rooms/ Library Reading Rooms	0.6	F1	C1	W1
Research Laboratory	0.7	n/a	C1	n/a
Public Area/Lobbies/Corridor	<1.5	n/a	C1	W1

**Notes:**

*a* Consult USC Project Manager for required RT and acoustics finishes requirements

*n/a* Acoustical treatment not required.

*C1.* Suspended acoustical ceiling system of minimum NRC 0.7; material types to be confirmed/approved by USC Project Manager

*C2.* Sound absorptive ceiling mounted panels; panel types and mounting location to be confirmed/approved by USC Project Manager.

*F1.* Carpet or equally sound absorptive floor covering.

*F2.* Wood or equally sound reflective floor covering; types to be confirmed/approved by USC Project Manager.

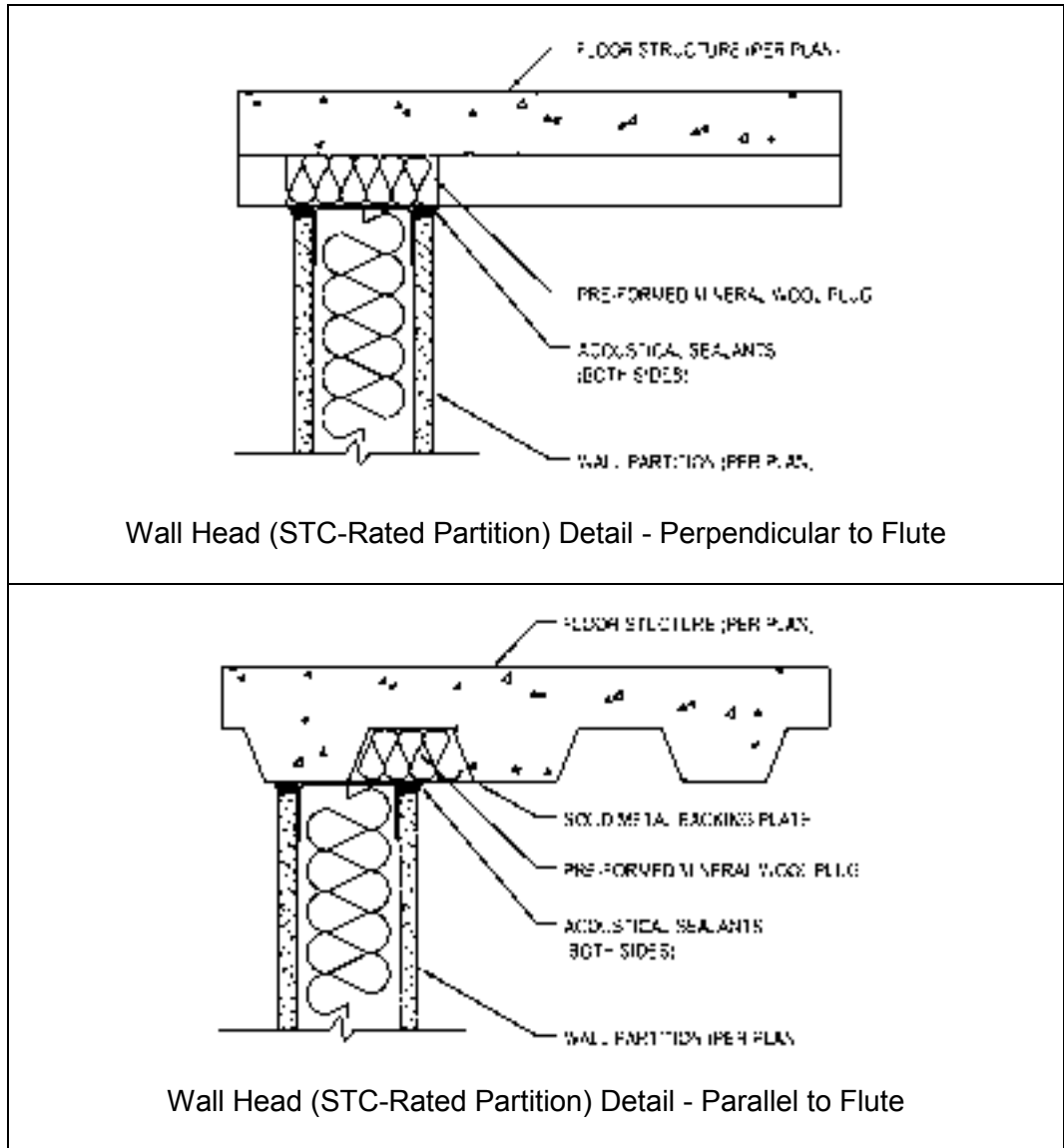
*W1.* Acoustical absorptive wall mounted panel, types and panel mounting to be confirmed/approved by USC Project Manager.

*W2.* Acoustical reflective/diffusive wall mounted panel, types and mounting location to be confirmed/approved by USC Project Manager.

## USC DESIGN GUIDELINES

### C. Design Considerations -

1. STC-rated wall construction connections at the top, floor slab/ decking, shall be sealed thoroughly following the suggested details provide below:

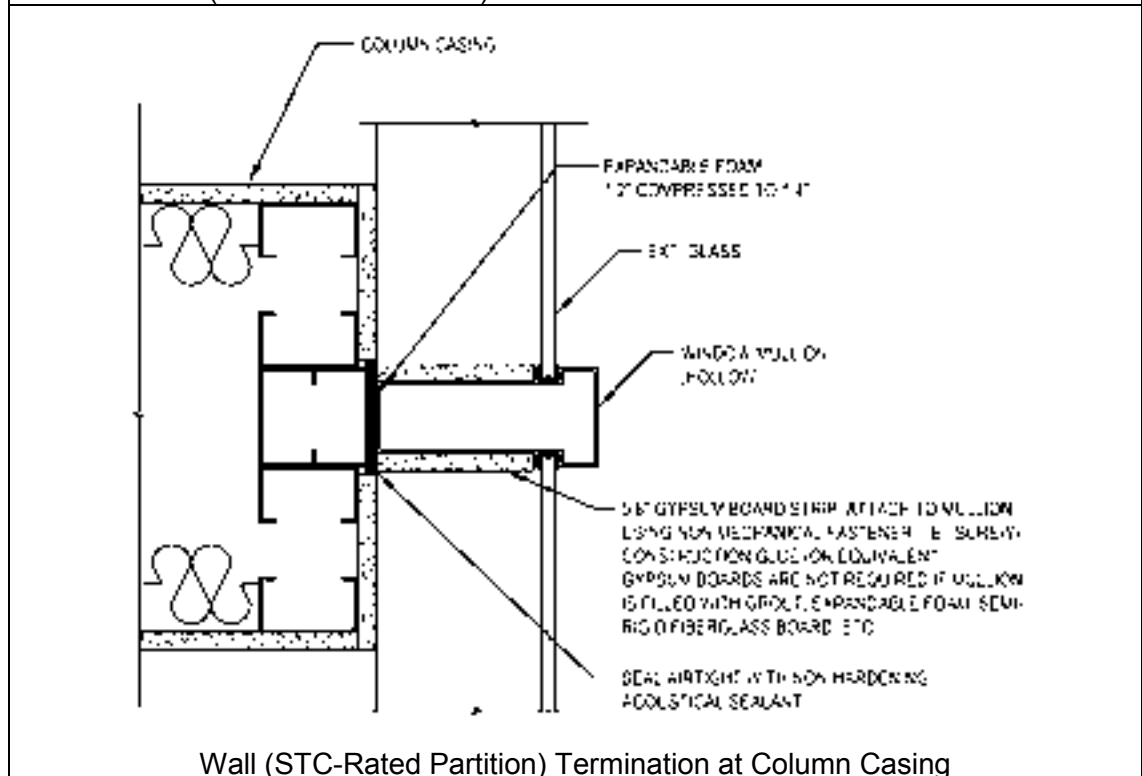
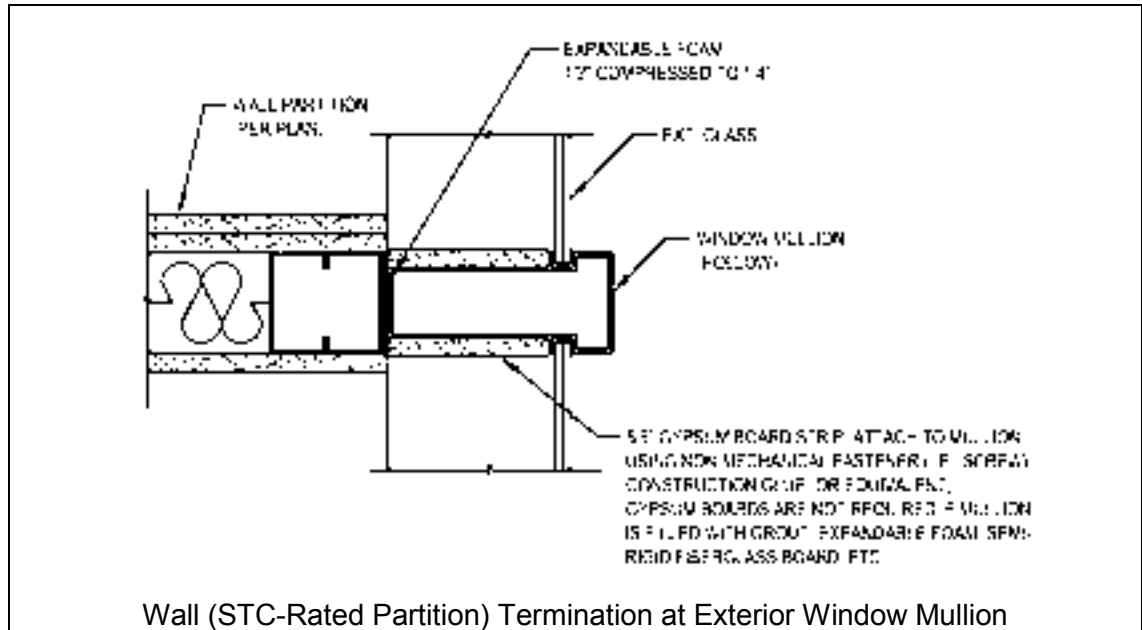


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## USC DESIGN GUIDELINES

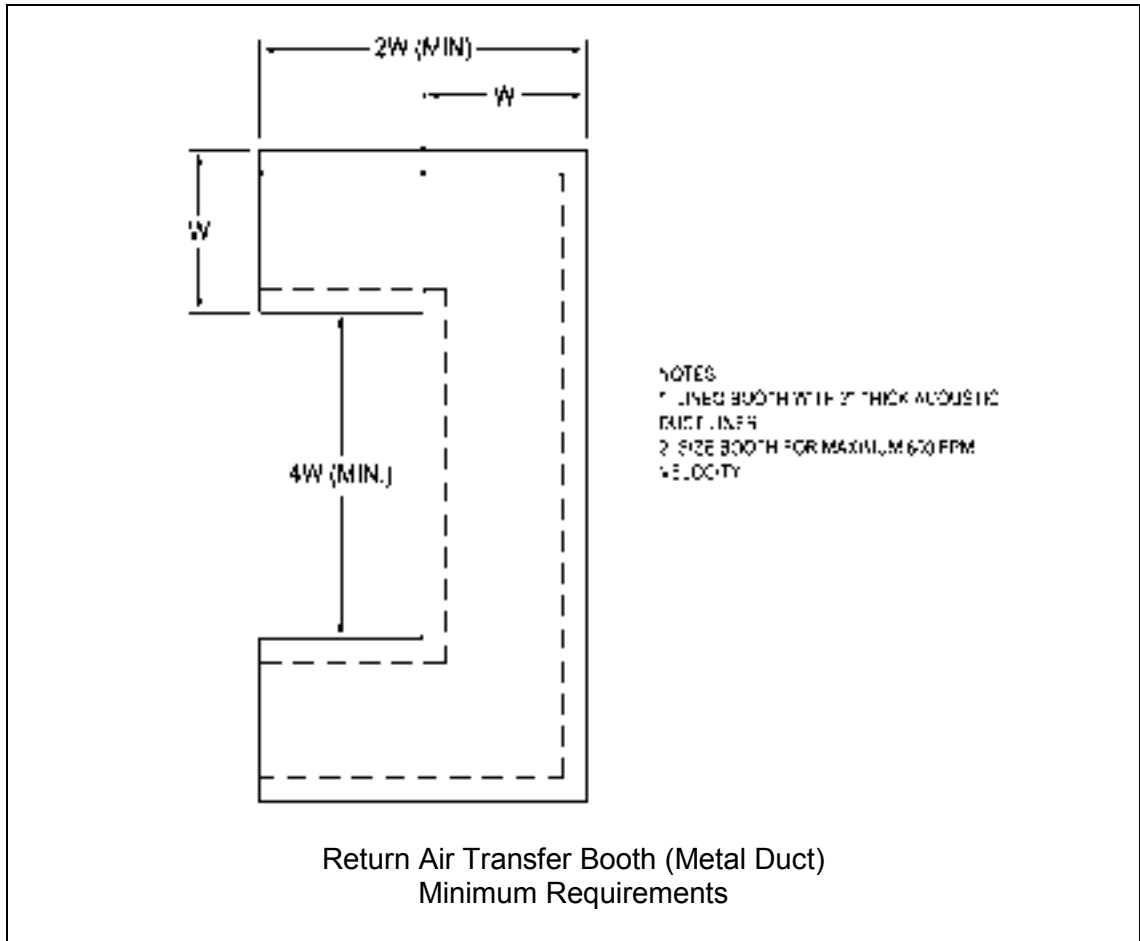
2. STC-rated wall construction connections at exterior window mullion and/or building column casing, shall be sealed thoroughly following the suggested details provide below:



3. Return air ceiling plenum would not be acceptable for the spaces with the partition walls of STC 50 and higher, use ducted return air systems.
4. Avoid installing electrical outlets back-to-back on the partition walls with STC 50 and higher sound ratings.

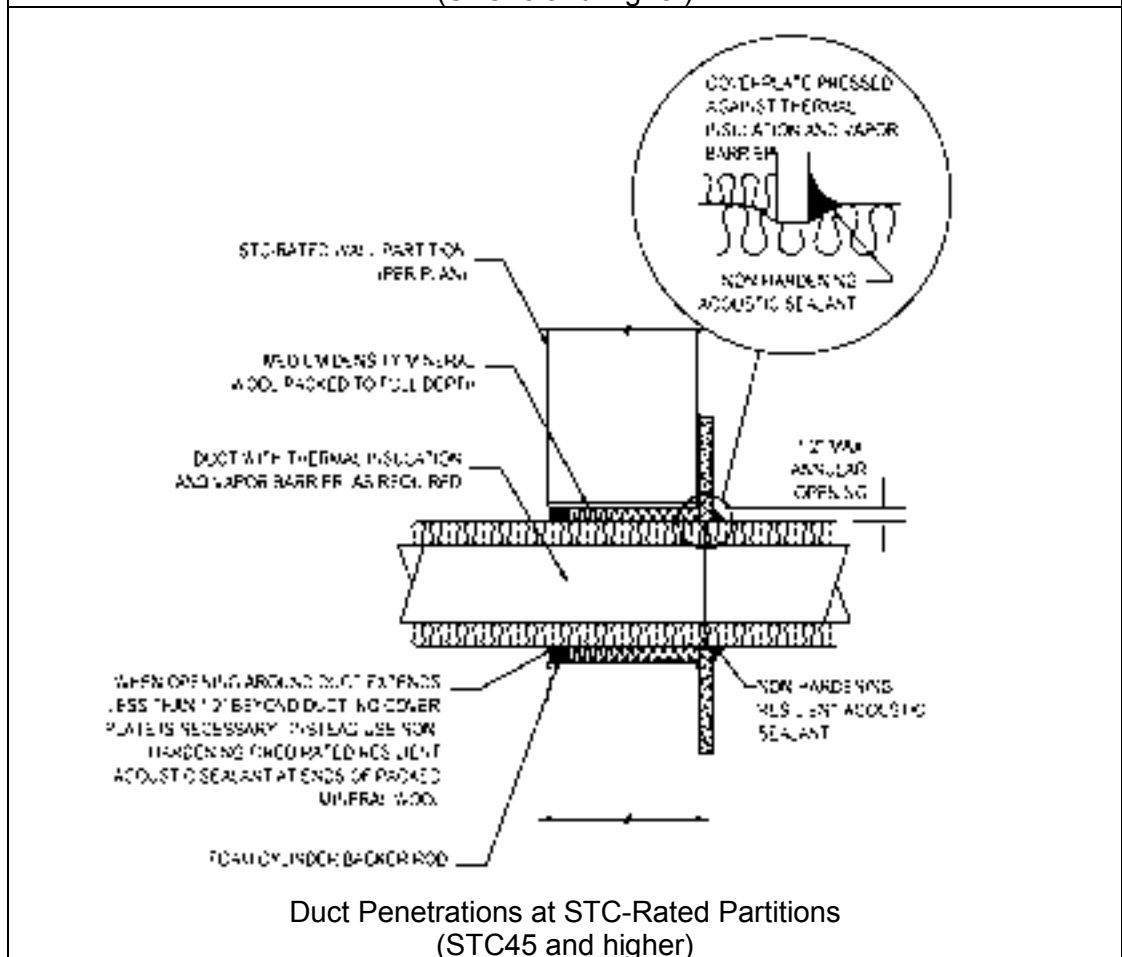
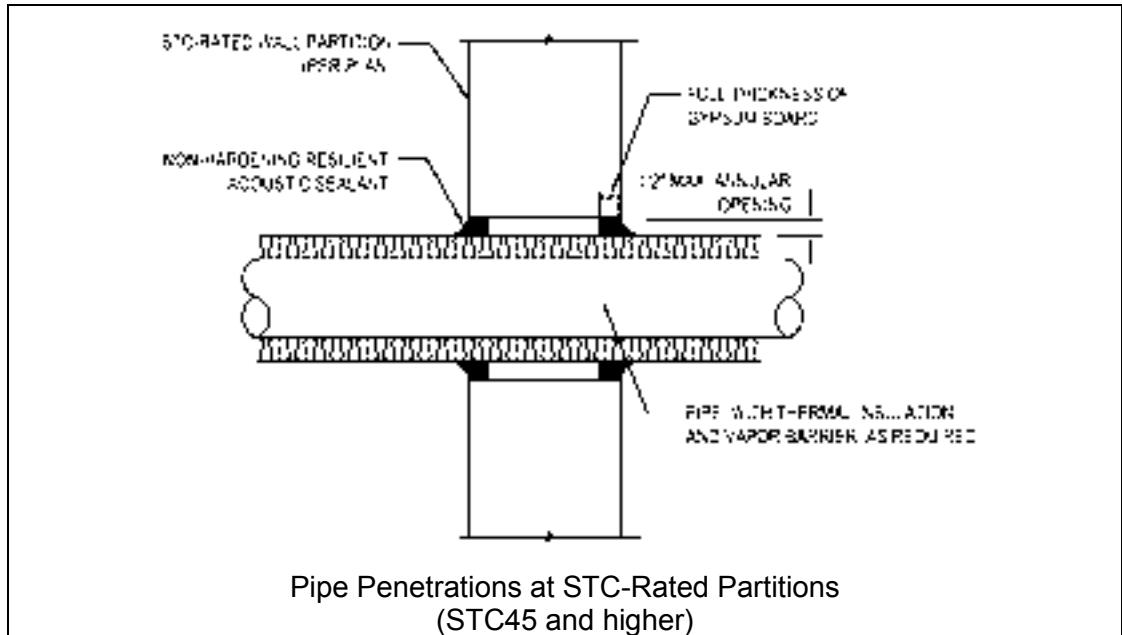
## USC DESIGN GUIDELINES

5. Ceiling return air plenum, STC 45 partition walls only, will require acoustically lined air-transfer booth, per detail below:



## USC DESIGN GUIDELINES

6. Seal all wall duct/pipe penetrations through STC 45 and higher partition walls per suggested details provided in below:



## USC DESIGN GUIDELINES

### 3. MECHANICAL/ELECTRICAL SERVICES NOISE AND VIBRATION CONTROL REQUIREMENTS

A. HVAC Mechanical Services Noise Criteria (verification tests per National Environmental Balancing Bureau "Procedure Standard for Measurements of Sound and Vibration", 2<sup>nd</sup> Edition 2006):

Occupied Space	Design Noise Criteria <sup>1,2</sup> (Maximum NC Level)	NC Curves
Theater/Music Recital/ Music Practice Rooms	25 <sup>3</sup>	
Lecture/Seminar Rooms/Multipurpose Rooms	30	
Classrooms	35	
Offices	35	
Conference Rooms	35	
Teaching Laboratory	35	
Research Laboratory without fume hood	40	
Research Laboratory with fume hood	50	
Public Area/Lobbies/ Corridor	45	
Clean Rooms	45-55 <sup>4</sup>	
Patient Rooms	35	
Medical Exam Rooms/ Clinical Offices	35	
Student Housings (Bedrooms)	35	
Library (Reading Rooms)	30	
Library (Stack Areas)	35	

*Notes:*  
 1 For areas not shown above consult with USC Project Manager.

## USC DESIGN GUIDELINES

- 2 See NC curves (chart) for the frequency spectrum.
- 3 Confirm with USC Project Manager.
- 4 NC55 applies to Labs with fume hoods in use.

- B. Ducts' Air Velocities and Mechanical System Components:
1. Ductwork Air Velocity Design Limits:

Primary Ductwork (Ducts Inside Shafts)	Maximum Air Velocity, Metal Ducts (fpm) <sup>1</sup>	
Main Supply Riser	1,400	
Main Return/ Exhaust Riser	1,500	
Secondary Ductwork within Spaces with NC	Maximum Air Velocity, Metal Ducts (fpm) <sup>2</sup>	
	Main Loops	Secondary Branch
25	800	450
30	900	550
35	1000	600
40	1200	750
45	1400	950
Transfer Air Duct (Return Air Booth) <500 fpm		
<p><i>Notes:</i></p> <p>1 If main supply/return duct passes over or adjacent to noise sensitive spaces (NC30 or lower), consult with USC Project Manager for acceptable duct air velocity.</p> <p>2 Duct air velocities, shown above, are for rectangular ducts. The above maximum air velocities could be increased by 30 percent if circular or oval metal ducts are used, subject to approval by USC Project Manager.</p> <p>3 Duct air velocity to be reduced where duct passes over an occupied space with no ceiling, consult with USC Project Manager.</p>		

2. Standard Air Terminal (Variable Air Volume Box) Selection Guidelines, selection is based on maximum 1 inch pressure drop.

VAV <sup>1,2</sup> Inlet Size, inch	Maximum Airflow (CFM)	Discharge NC at Maximum CFM
6	175	30
	300	35
	350	35
	400	40
	450	40
7	250	35
	400	35
	500	35

## USC DESIGN GUIDELINES

VAV <sup>1,2</sup> Inlet Size, inch	Maximum Airflow (CFM)	Discharge NC at Maximum CFM
	600	40
8	500	35
	600	35
	700	35
	700	35
9	500	35
	700	40
	800	40
	900	45
10	650	30
	800	35
	1000	40
	1200	40
12	900	30
	1200	35
	1500	40
	1800	45
14	1100	35
	1800	40
	2100	45
	2400	50

*Notes:*

- 1 Do not place VAV box directly over the ceiling of spaces with maximum NC30 Rating.
- 2 Consult USC Project Manager for required noise mitigations measures for VAV Box installation within NC35-40 rooms with exposed structural ceiling (no acoustical finished ceiling).

3. Quick Response Air Valves Selection Guidelines. Selection is based on 1 inch pressure drop and based on assumption that the room has a finished (acoustical) ceiling.

Quick Response Air Valves (placed above room ceiling structure) Inlet Size, inch	Maximum Airflow (CFM)	Discharge/Exhaust NC at Maximum CFM
8	100	35/30
	300	40/35
	500	50/45
	600	50/50
	700	55/50
10	300	45/35
	500	50/40
	500	50/45
	1000	50/50
12	400	45/35
	800	50/40

## USC DESIGN GUIDELINES

Quick Response Air Valves (placed above room ceiling structure) Inlet Size, inch	Maximum Airflow (CFM)	Discharge/Exhaust NC at Maximum CFM
	1200	50/45
(2)-10	600	45/40
	1000	50/40
	1600	50/45
	2000	55/50
(2)-12	1200	45/40
	2000	50/45
	2400	50/45
	3000	55/50
(3)-12	1800	45/40
	3000	50/45
	4200	55/50
	4500	55/50
<i>Notes: Consult USC Project Manager for Air Valves NC requirements if room has no finished ceiling.</i>		

4. Design Considerations:
- a) Avoid placing VAV boxes over spaces without finished ceiling, consult with USC Project Manager.
  - b) Avoid duct connections that cause air turbulence or give rise to air swirling.
  - c) Avoid duct routes with sudden change in duct geometries and cross-sectional areas.
  - d) Avoid placing air volume dampers closer than 5 feet from room air diffusers and grilles.
  - e) Use duct-liner to attenuate air generated duct noise, confirm with USC Project Manager as to applicability of duct liner.
  - f) Use pre-manufactured duct silencers at the Standard VAV boxes discharge and intake air sides where VAV boxes serving spaces of NC35 and lower.
  - g) Consult USC Project Manager for type of duct silencers suitable for Laboratories Air Valves.
  - h) Avoid using straight through air transfer booth, use “L” or “U” shape lined air transfer booth.
  - i) Avoid using air diffusers/ grilles with integrated volume dampers in the spaces with NC30 and lower.

## USC DESIGN GUIDELINES

### C. Mechanical Equipment Vibration Isolation Minimum Requirements:

Mechanical Equipment <sup>1</sup>	Mechanical Specs	Located on Slab on Grade		Located on Upper Floors <sup>2</sup>	
		Base Type	Isolator Type	Base Type	Isolator Type
Chillers - Reciprocating - Centrifugal	All	A	2	A	3
		A	1	A	3
Air Compressors	All	C	3	C	3
Pumps - Inline - End-suction/ Close-coupled	All	A	3	A	3
		C	3	C	3
Axial Fans <sup>3</sup>	>2.0 in. SP	B	3	B	3
Centrifugal Fans	<40 HP	B	3	B	3
	>40 HP	C	3	C	3
Air-Handling Units <sup>4</sup>	<15 HP	A	3	A	3
	>15 HP	B	3	C	3
Packaged Rooftop Equipment	All	n/a	n/a	D	3
Notes:			Base Types:		
1. Consult USC Project Manager for specific vibration isolations requirements.			A. Per equipment manufacturer's standard guidelines		
2. Not applicable to buildings with floor structure vibration velocity criteria of maximum 1000 micro-inch per second, consult USC Project Manager for specific vibration isolations requirements.			B. Structural Steel Base		
3. Consult USC Project Manager for structural requirements of Concrete Inertia Bases.			C. Concrete Inertia Base		
4. Internally isolated fans using Spring Vibration Isolators with minimum 2 inch deflections.			D. Vibration Isolated Curb		
			Isolator Types:		
			1. Neoprene Pads, minimum 1/2" thick		
			2. Neoprene Mounts, minimum 1/2" static deflection		
			3. Spring Isolators, minimum 2" static deflection		

### D. Design Considerations:

1. Avoid planning mechanical rooms adjacent to or above of occupied spaces with NC35 and lower. Consult with USC Project Manager for specific requirements.
2. Mechanical room directly above NC35-45 spaces should consider acoustically isolated concrete floor slab, (floating floor slab, others).
3. Avoid routing active flow pipes through spaces with NC40 and lower.
4. Provide appropriate vibration isolations for all piping and ducts traveled within the mechanical room and beyond, consult USC Project Manager.
5. Avoid placing roof mounted mechanical equipment (i.e., Air-cooled Chillers, Cooling Towers and Air Handling Units) over acoustically sensitive areas of NC40 and lower. Consult USC Project Manager.
6. Perform outdoor noise impact analysis (where proposed outdoor mechanical equipment yard is close to adjoining campus buildings) to determine potential noise impacts and develop mitigation options, confirm with USC Project Manager.



# USC DESIGN GUIDELINES

## 4. STRUCTURAL FLOOR VIBRATION REQUIREMENTS

### A. Structural Floor Vibration Criteria:

1. Structural Floor Vibration Design Criteria for Vibration Sensitive Equipment/Systems, minimum requirements.

Applicable Space/ Occupancy	Vibration Criteria (VC), <sup>1</sup> $\mu\text{in/s}$	VC Curves <sup>2</sup>
Hospital recovery rooms	8000	
Hospital surgical suites, microscopes up to 200X Power	4000	
Labs with optical microscopes to 400X Power, microbalances, proximity and projection aligners	2000	
Inspection and lithography equipment (including steppers) to 3 $\mu\text{m}$ line widths.	1000	
Optical microscopes to 1000X Power, lithography and inspection equipment to 1 $\mu\text{m}$ line widths.	500	
Electron microscopes (SEMs and TEMs) and E-Beam systems.	250	
Un-isolated laser and optical research systems, long path, laser-based, E-Beam lithography systems working at nanometer scales.	125	

**Notes:**

- 1 Consult USC Project Manager for structural design requirements for buildings occupancy require vibration criteria (VC) below 2,000 micro-inches per second.
- 2 Vibration limits as measured in 1/3 octave band frequency.

## USC DESIGN GUIDELINES

2. Structural Floor Vibration Design Criteria for Human Comfort, minimum requirements.

Applicable Space/ Occupancy	Maximum Vibration Limits (VL), Peak Acceleration, <sup>1,2</sup> Percent Gravity (%g)
Outdoor Footbridges, Athletic Facilities (Rhythmic Activities)	5.0
Indoor Footbridges/Dining Hall	1.5
Offices/ Academic Classrooms	0.5
Student Dorms/Patient Rooms	0.5
<i>Notes:</i>	
1 Consult USC Project Manager for recommended Vibration Limits for spaces not mentioned above.	
2 Vibration Limits are applicable to 4-8 Hz band frequency.	

- B. Site Vibration Investigations (Ambient/Existing Condition): A site ambient vibration survey shall be conducted for building projects, which require vibration criteria within categories of VC-D (250  $\mu\text{in/s}$ ) and VC-E (125  $\mu\text{in/s}$ ). Site ambient vibration measurement shall determine vibration propagation specifics of the ground and assess preliminary mitigation options. In particular, the site vibration assessment should include:
1. Vibration Measurement Study Area – The vibration measurement area should be located within the boundary of the proposed facility (measurements locations shall be closest to the existing outdoor vibration sources, i.e., roadways, metro lanes, mechanical plants) and if possible within general vicinity of the location of the space where future vibration sensitive equipment are planned.
  2. Vibration measurements duration – The ambient vibration measurements shall be recorded for minimum 15 minutes or as required by the USC Project Manager to capture all nearby vibration sources (i.e., auto traffic, rails). The timing of vibration measurements should coincide with the timing of peak-traffic volume on the nearby roads and rails.
  3. Ground vibration levels should be recorded on three orthogonal directions relative to the local ground.
  4. The site ambient vibration should be recorded in velocity (amplitude in the unit of root-mean-square, RMS) using standard one-third octave band center frequency (between 1 Hz and 100 Hz), unless specified otherwise by USC Project Manager.
  5. The measured ground vibrations levels shall be reported as the average (linear average) and the maximum ( $L_{\text{max}}$ ) recorded levels during the measurement period.
- C. Design Considerations:
1. Place vibration sensitive equipment at the stiffest point of the building structural slab (i.e., near building column, girders, etc.)
  2. Avoid locating vibration sensitive equipment near the building foot traffic corridors.

## USC DESIGN GUIDELINES

3. Provide heavy/stiffer/highly damped floor slab to resist foot-fall induced structural vibration.

### 5. VERIFICATION TEST REQUIREMENTS

#### A. Building Sound Insulation (STC) Test:

1. At the direction of USC Project manager, perform Building Sound Insulation (STC) Test for the Project STC-rated wall partitions, doors, and operable partitions in accordance with the latest version of ASTM Standard E 336. Test shall be conducted by engineers/technicians qualified in work of this nature.
2. Sound Transmission Class ratings (Field STC) shall be determined according to the latest version of ASTM E 413. Acoustical reports shall be prepared by an engineer/technician qualified in the work of this nature. The reports shall include the engineer/technicians name, date of test, FSTC rating, and noise reduction (dB) values in octave band frequencies from 125 to 4000 Hz. The acceptable deficiency between the Project Design STC and Field STC ratings shall not exceed 5 STC points (acceptable Field STC = Design STC Rating – 5 STC points).

#### B. Mechanical HVAC Noise Levels (NC) Test:

1. After installation of the new HVAC equipment and after the system has been balanced, contractor shall provide the Mechanical HVAC Noise Levels (NC) Tests. Test shall be performed by TAB Agency/Contractors, pursuant to the current Standards of AABC ("Procedure for Measurements of Sound and Vibration, latest Addition") acceptable to the USC Project Manager. Sound testing shall be accomplished only during periods when no other trades are working within the building and the HVAC System is fully balanced. The NC test shall be conducted for minimum one room from the following list, or as designated by USC Project Manager.
  - a) Occupied space adjacent to mechanical equipment rooms
  - b) Private offices
  - c) Conference rooms
  - d) Auditorium
  - e) Lecture hall
  - f) Library
  - g) Dormitory
  - h) Sound or vibration sensitive laboratory
  - i) As selected by USC Project Manager.
2. Test Procedures:
  - a) The Mechanical HVAC Noise Testing shall be performed in accordance with standards of AABC ("Procedural Standards for Measurement of Sound and Vibration, latest edition").
  - b) The test report shall include: the specified NC levels, the measured NC levels, the octave band sound levels in dB (from 63 to 8000Hz), a sketch of measurement locations.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 14 0000 ELEVATOR GENUSC DESIGN GUIDELINES ERAL REQUIREMENTS

### PART 1 GENERAL REQUIREMENTS

#### 1.1 INTRODUCTION

- A. This Facilities Standards Manual is for use in the design and implementation of vertical transportation equipment in new and existing University of Southern California (USC) multistory campus structures. The implementation of these standards is required of both in-house and outside design and construction professionals. All engineering, equipment, labor, and permits required to satisfactorily complete elevator modernization required by Contract Documents.
- B. The University's Facilities Planning and Management Department currently maintains the majority of the vertical transportation equipment on campus. One intent of these standards is to ensure a high quality of equipment which is maintainable by the campus staff of elevator mechanics. Another aim is to provide continuity of equipment with regard to major component areas.
- C. These Facilities Standards, for the most part, govern new construction. It is understood that requirements cannot be met' on all renovations/modernizations. Where new equipment is provided, the applicable standards will apply. Where it is cost effective or required to retain existing equipment, said equipment shall be brought up to code and placed in like-new condition.
- D. A diverse array of building types are planned for, and currently exist, on the campus of the University of Southern California. Vertical transportation systems and their respective performance criteria will vary by building type. In all multi-elevator buildings elevating analysis must be performed and target group criteria and individual car criteria specified.

#### 1.2 GENERAL DESIGN PHILOSOPHY

The following equipment characteristics should be considered when designing and selecting equipment types for installation on the USC campuses:

- A. **Design Quality:** These standards (Chapter 4) list currently approved installers and major components. University approval must be garnered to deviate in any way from that which is listed. The standards also provide for quality assurance in material fabrication, material gauges, performance levels, noise levels, and workmanship. Any deviation in these areas will require the replacement of non-compliant equipment. It is anticipated that the University will receive each approved manufacturer's top-of-the-line or "Class A" product. Second tier products will not be considered.
- B. **Maintainability:** All equipment must be maintainable by the on-campus staff of trained elevator mechanics. Acceptance of new technologies will only be considered in conjunction with an intensive formal training program conducted by the equipment manufacturer/installer. Training shall parallel that provided to the installers technicians and include both classroom and field (hands-on) instruction. Reference Chapter 6 of these standards. Maintainability requirements include the ability to procure replacement parts as

## USC DESIGN GUIDELINES

well as special maintenance tools. The University will not consider equipment which requires special adjusting, troubleshooting, etc., tools that cannot be purchased through normal purchasing channels. Special tools provided to the University shall include all top-level, solid-state diagnostic tools and related software documentation which the equipment manufacturer and installer supplies to his adjusters and service personnel.

- C. Life Expectancy: It is anticipated that any new installation or renovated installation will be capable of providing at least 20 years of dependable service before renovation is again considered. The above assumes that a quality, full maintenance program remains in effect throughout the life of the equipment.
- D. Consistency of Standards: To ensure a consistent level of vertical transportation equipment quality, compliance with performance standards, quality workmanship, and compliance with contract documents, the University of Southern California mandates that Lerch Bates, Inc (contact: Steven Frame 949-394-1106) be employed on all projects requiring the installation of vertical transportation equipment.

The scope of services provided by the elevator consultant shall include the following:

### New Installation

- 1. Schematic Design Phase
  - a. Attend meetings to consult with the Architect and/or University, and Design Team members to discuss the project program and establish design requirements. Unique requirements of the building or anticipated occupancy and their influence on the vertical transportation systems are identified at this time.
  - b. Establish the analysis design criteria.
  - c. Utilize the selected design criteria and projected populations to conduct a vertical transportation equipment analysis. Select and recommend the most-viable alternatives.
  - d. Submit a written report based upon the analysis and preliminary planning indicated on the schematic architectural drawings. Report shall include:
    - 1) A definition of the selected design criteria and terms.
    - 2) Establish criteria to obtain proper levels of vertical transportation service.
    - 3) Results of computer and/or manual study and analysis calculations.
    - 4) Recommended solutions.
    - 5) Deviations from USC Facilities Standards covering vertical transportation equipment, if any.
  - e. Attend meetings to discuss the report and alternative solutions. Update the analysis and recommendations based upon the revised designs. Studies shall continue until a final design is selected by the University. Upon resolution and selection of final design, the following preliminary information shall be provided:
    - 1) Basic elevator/escalator core dimensions and arrangements in a CADD format.
    - 2) Outline specifications.

## USC DESIGN GUIDELINES

- 3) Equipment budget estimates.
2. Design Development Phase
  - a. Provide a final analysis report from the schematic design studies and final solutions.
  - b. Provide final outlines of equipment for budget pricing.
  - c. Provide detailed CADD generated design information and arrangements for the development plan selected. Information shall include:
    - 1) Scaled general arrangement drawings in the format requested by USC.
    - 2) Information for interface with other engineering disciplines; i.e., structural, electrical, and mechanical requirements.
    - 3) Information for interface with related work to be accomplished by other Trades.
    - 4) Drawings for special or unique applications
  - d. Verify conformance with related codes.
  - e. Provide a final budget estimate of the equipment costs.
3. Construction Documents Phase
  - a. Provide architectural layout drawings for the vertical transportation equipment. Provide written comments along with advice, assistance or information on any items related to the drawings, as requested by the Architect.
  - b. Prepare a detailed and complete performance-based specification in the standard USC format. The specification shall include specific performance criteria, compliance with current codes, and establish the equipment quality level. Bid documents shall be configured to encourage competitive bidding.
  - c. Update equipment budget estimates to reflect the final designs.
4. Bidding and Negotiation Phase
  - a. Provide assistance on any bidding matter. Such assistance shall include:
    - 1) Consultations on bidding procedure.
    - 2) Evaluate the bids, clarify exceptions and ambiguities with the Bidders, and submit written recommendations.
    - 3) Assist with contract negotiations.
    - 4) Attend or conduct bid review meetings.
    - 5) Establish and review the material/delivery construction schedule.
5. Construction Services Phase
  - a. Review shop drawings submitted by Elevator Contractor for code, USC Facilities Standards, and contract document compliance. Review comments shall be incorporated on one sepia and two blue line drawings.
  - b. Conduct periodic installation reviews to determine that work is proceeding in accordance with the Contract Documents, USC Facilities Standards, and in general conformity with the intent of the design concept. Submit written reports which shall include the following:

## USC DESIGN GUIDELINES

- 1) List items of nonconformity.
  - 2) Percentage of equipment and components on the site and installed.
  - 3) Percentage of overall completion of individual or groups of elevators/escalators.
  - 4) Identify equipment or components not on the jobsite which could affect the installation schedule.
  - 5) Review applicability of Temporary Acceptance forms. Attend jobsite meetings to assist in resolution of installation problems. Review and comment on progress billing and verify Change Orders.
- c. Conduct a final installation review to document equipment compliance and performance with the contract requirements. Provide the Architect and University with a written report covering the measured performance data and itemized deficiencies. Make one additional review per elevator group to verify compliance with the deficiency report. (The job should then be substantially complete and operating in accordance with specified performance guarantees.) If additional reviews are required, they shall be billed as Additional Services.
  - d. Establish substantial completion and final completion dates.
  - e. Review contract close-out documents and warranties. Modernization Survey and Report.

### 1.3 GENERAL DESIGN GUIDELINES

#### A. Architectural

1. Elevator core locations shall be coordinated with the horizontal traffic flow and with the means of ingress and egress. Passenger elevators must be located on a "major path of travel" as required by the Americans with Disabilities Act (ADA).
2. Elevator lobbies should be designed to accommodate the movement of pedestrian traffic to other parts of the building. Should elevators face one another, the minimum width between entrances shall be 10 feet. Elements which create queues, such as exhibits, directories, etc., shall not be placed in elevator lobbies.
3. Wheelchair lifts shall not be used in new construction.

### 1.4 EQUIPMENT SELECTION

Selection of geared traction, gearless traction, or hydraulic elevators shall be determined by elevating analysis as well as estimated equipment costs. The elevator capacity shall be determined via the elevating analysis studies. At a minimum, platform sizes shall meet disabled access requirements and provide the capability of carrying a medical stretcher 24 inches wide and 84 inches long.

#### A. Hydraulic Elevators

1. Direct plunger hydraulic elevators may be employed for travel distances up to 45 feet with the following considerations:
  - a. Contract speed shall not exceed 150 feet per minute (f.p.m.).

## USC DESIGN GUIDELINES

- b. Elevating analysis must demonstrate that a hydraulic application will meet the USC criteria for good elevator service.
  - c. Calculations to determine anticipated up-starts per hour shall accompany the elevating analysis reports. Up-starts per hour shall not exceed 60.
  - d. Machine rooms, where possible, shall be located at the bottom terminal floor, adjacent to the hoistway.
2. Holeless hydraulic equipment meeting the above criteria may be considered with the following clarifications:
    - a. Cantilevered units will not be considered. Dual jacks will be provided on all installations.
    - b. Telescoping jacks will not be considered.
    - c. Travel distances shall not exceed 15 feet.
- B. Traction Elevators
1. Most Campus structures in excess of four stories will require the application of geared traction equipment. Overhead machine rooms are preferred. The following criteria shall be met when selecting geared equipment.
    - a. Travel distance shall not exceed 160 feet.
    - b. Speed shall be limited to 350 f.p.m maximum.
    - c. AC VVVF motor control shall have at least a five year track record of proven, successful service.

END OF SECTION



# USC DESIGN GUIDELINES

## 14 1000 ELEVATOR SCHEMATIC DESIGN REQUIREMENTS

### PART 1 GENERAL

During Schematic Design, Vertical Transportation requirements are discussed and analyzed. Each type of campus structure will have unique needs for both passenger movement and, perhaps, service functions (material movement).

Analysis results will provide for the proper selection of the number of vertical transportation units, location of units, capacity and speed. Submittals so indicating shall be prepared and submitted for USC review.

Preliminary Design Data shall include hoistway and pit plans, hoistway sections, and machine room layouts. Information necessary for coordination with other disciplines should also be provided at this time.

#### 1.1 ELEVATOR GROUP CRITERIA

##### A. Passenger Elevators

The following table provides minimum acceptable elevating criteria to be used as a basis for design in the various types of campus structures:

<b>MINIMUM CRITERIA FOR ELEVATORING NEW CAMPUS STRUCTURES</b>				
<b>Building Type</b>	<b>Peak Period</b>	<b>Traffic Flow</b>	<b>Average Interval (Seconds)</b>	<b>Minimum Handling Capacity (%)</b>
Administrative Offices	AM up-peak	One-way	25-30	12-13
Professional Offices	AM up-peak	Two-way	30-35	8-10
Classroom Building	Hourly	Two-way	35-40	6-8
Housing	PM (dinner)	Two-way	35-40	6-8
Parking Structure	AM up-peak	Two-way	40-45	8-10

1. Average Interval is the average-time increment between elevator departures from the terminal floor during a heavy-traffic period.
2. Handling Capacity is the number of persons or percentage of building population that can be transported by vertical systems during this same period of heavy traffic.
3. It is extremely important that the basis of any elevating calculations be included in all analysis reports. This is especially true of any population determinations when not predetermined by the University. Analysis results must be revisited as information and architectural drawings develop.
4. If it can be anticipated, future building use should also be considered at this time. The possibility of change in the type of building occupancy and reassignment of building area that would result in a greater volume of passenger traffic shall be investigated. Potential building expansion should be considered. When possibilities exist, the building framing shall be arranged to permit future installation of an additional elevator to handle a future increase in traffic volume.

## USC DESIGN GUIDELINES

### B. Service/Freight Elevators

1. Service Elevators. Most structures built on the USC campus will not require a dedicated service elevator. In any event, service needs should be analyzed and presented for University review.
2. The following criteria will apply to the use of service elevators:
  - a. Any office building with a total gross floor area approaching 250,000 sq. ft. should be designed to include one dedicated service elevator.
  - b. An additional service elevator should be recommended for each additional 350,000 sq. ft. gross floor area.
  - c. Classroom buildings, especially those containing labs, should be considered on an individual basis.
  - d. Service elevators should be hospital shaped with a minimum capacity of 4,000-5,000 lbs. They should be applied with a minimum 7'-0" clear high car enclosure and 4'-0" wide x 8'-0" high, two-speed, side-opening doors.
3. In situations which demand the application of a swing passenger/service elevator:
  - a. It is imperative that the swing car be in group operation during peak traffic periods. This shall be accomplished via automatic time clock.
  - b. Anticipate that the interior finishes of the designated swing car will be damaged by freight handlers and not present a good appearance to passengers. Durable textured stainless steel finishes shall be employed.
  - c. The best application for a swing car is to have reverse openings in service lobbies at all floors or at least the first floor lobby. This keeps freight out of the main lobbies, restricts passenger usage of the elevator and eliminates false corridor call registration which will occur if the normal front passenger doors are also used for freight.
  - d. Swing service cars should be considered in dormitories of five or more stories.
  - e. Freight Elevators: At campus settings, true freight elevators are usually considered to support food service functions or transport palletized materials. Due to cost and space considerations, analysis reports shall provide thorough justification for this type of installation.

END OF SECTION

# USC DESIGN GUIDELINES

## 14 2000 ELEVATOR DESIGN DEVELOPMENT REQUIREMENTS

### PART 1 GENERAL

At this stage of design, the number and arrangement of vertical transportation equipment should be virtually set. Work should continue to refine machine room layout and location and develop the information necessary to prepare performance based technical specifications. It is especially important that coordination between different engineering disciplines occur early in the Design Development Stage.

The majority of the coordination issues should be addressed within the Elevator Consultant's Design Data (layouts). This includes the sizing of equipment areas, power data, equipment heat emission data, and structural forces. All structural data for USC projects shall account for seismic forces, where applicable.

#### 1.1 RELATED WORK

The Project Architect or Design Team shall ensure that all work related to the installation of elevators (that which is not going to be installed by the Elevator Contractor) is included in the proper specification section. Related work can include the following:

- A. Legal Hoistway and Pit:
  - 1. Clear, plumb, substantially flush hoistway with variations not to exceed 1" at any point.
  - 2. Bevel cants not less than 75° with the horizontal on any rear or side wall ledges and beams that project or recess 2" or more into the hoistway. Not required on hoistway divider beams.
  - 3. Divider beams between adjacent elevators at each floor, pit and overhead. Additional ear and counterweight rail supports where floor heights exceed 14'-0". Building supports not to exceed deflection of 1/8".
  - 4. Installation of guide rail bracket supports in concrete. Inserts or embeds, if used, will be furnished by the Elevator Contractor.
  - 5. Wall blackouts and fire rated backing for control and signal fixture boxes which penetrate walls.
  - 6. Cutting and patching walls and floors. Division 14 Facilities Standards for USC Vertical Conveying Systems 13.
  - 7. Wall pockets and/or structural beams for support of machine, sheave, and dead-end hitch beams. Support beam deflection shall not exceed 1/1666 of span under static load. Machine hold down means for hoist machines mounted beside or below hoistway.
  - 8. Erect front hoistway wall after elevator entrances installed.
  - 9. Grout around hoistway entrances and sills.
  - 10. Lockable, self-closing, fire-rated pit door.
  - 11. Pit access ladder for each elevator and pit divider screen. Structural supports for car buffer impact loads, and rail loads.
  - 12. Structural support for car and counterweight buffer impact loads, guide rail loads, and compensation sheave tie-down upthrust.

## USC DESIGN GUIDELINES

13. Waterproof pit. Indirect waste drain and sump with flush grate and pump. Provisions for the removal and storage of waste material by an approved method of the local governing authority.
  14. Protect open hoistways and entrances during construction per OSHA Regulations.
  15. Protect car enclosure, hoistway entrance assemblies and special metal finishes from damage after installation.
  16. Hoistway venting or pressurization to prevent accumulation of smoke and gas as required by Local Building Code.
  17. Structural steel channel frames, floor to building beam above, header and angle sills for vertical Bi-parting-parting hoistway entrances.
  18. Stone entrance frames at main lobby floor. (Set after elevator sub frame is installed.)
  19. Seal fireproofing to prevent flaking.
  20. Glass enclosed hoistways. Laminated glass to meet the requirements of ANSI 297.1 and California Title 8 and 24. Interior ledges created by glass mullions shall not exceed 2".
  21. Continuous vertical car and counterweight guide rail support required full height of hoistway.
  22. Partition between machine room and hoistway where hoist machine mounted beside hoistway.
  23. 3'-0" square hole in pit floor for Elevator Contractor to install protective, secondary containment casing. Fill hole with concrete after jack and membrane installation. Seal pit with non-permeable epoxy.
  24. Pit support framing for jack cylinder and buffer loads.
  25. Opening in hoistway wall for hydraulic piping. Trench and backfill underground piping.
- B. Legal Machine Room:
1. Enclosure with access ships ladder or stair with guard railing. Include similar access to overhead machinery space.
  2. Self-closing and locking access door.
  3. Constant cooling and heating to maintain temperature range between 65 and 85 degrees F. Maximum relative humidity 85% non-condensing.
  4. Paint walls, ceiling and floor.
  5. Class ABC fire extinguisher.
  6. Self-closing and locking governor access door and access means.
  7. Fire sprinklers.
  8. Coordinate secondary containment of tank with elevator installer.
- C. Electrical Service, Conductors and Devices:
1. Lighting and GFCI convenience outlet in pit, machine room and overhead machinery space.

## USC DESIGN GUIDELINES

2. Conduit from the closest hoistway of each elevator group or single elevator to the firefighters' control room and/or main control console. Coordinate size, number and location of conduits.
  3. Three-phase mainline copper power feeder to terminals of each elevator controller in the machine room with protected, lockable "off," disconnect. Auxiliary disconnects in multi-level machine room.
  4. Single phase copper power feeder to each elevator controller for lighting and exhaust blower with individual protected, lockable "off," disconnect switch located in machine room.
  5. Single phase power feeders to machine room elevator group control panel and VGA with single phase, protected, lockable "off," disconnect switch.
  6. Firefighters' telephone jack and announcement speaker in car with connection to individual elevator control panels in elevator machine room and elevator control panel in firefighters' control room, all if required by code.
  7. Emergency public telephone service with dedicated line to individual elevator control panel in elevator machine room.
  8. Products of-combustion sensor (NFPA No. 72, Chapter 5-3) in each elevator lobby, for each group of elevators or single elevator and machine room to initiate firefighters' return feature. Detector at top of hoistway if sprinkled. Provide means for service access from outside the hoistway. Provide sensor signal wiring from hoistway or machine room connection point to controller terminals.
  9. Temporary power and illumination to install, test and adjust elevator equipment.
  10. Means to automatically disconnect power to affected elevator drive unit and controller prior to activation of machine room overhead fire sprinkler system, and/or hoistway overhead fire sprinkler system.
  11. Power feeders to main control console and firefighters' control panel VGA.
  12. Power feeder to elevator intercom amplifier located in the elevator machine room.
  13. Three phase power feeder to each freight elevator power door controller in machine room with protected, lockable "off," disconnect switch.
  14. Copper power feeder to each elevator controller in machine room for elevator car heating and air conditioning unit.
- D. Standby Power Provision:
1. Standby power of the same voltage characteristics via normal electrical feeder to run one elevator at a time in each elevator group, and/or single elevator unit, at full-rated car speed and capacity.
  2. Conductor from auxiliary form "C" dry contacts, located in the standby power transfer switch to a single designated elevator control panel in each elevator bank and/or single elevator unit. (Provide a time delay of approximately 30-45 seconds for pre-transfer signal in either direction.)
  3. Standby single-phase power to group controller, and each elevator controller for lighting, exhaust blower, emergency call bell, intercom amplifier, hoist machine cooling fan, car heating and air conditioning unit.

## USC DESIGN GUIDELINES

4. Means for absorbing regenerated power during an overhauling load condition, per NEC 620-101. Elevator will employ SCR drive, presenting a non-linear active load.

### E. Car and Corridor

1. Car flooring.
2. Elevator lobbies.

## 1.2 DESIGN DEVELOPMENT SUBMISSION REQUIREMENTS

### A. Final Design Concepts

1. Final elevating analysis updated to reflect any changes occurring since previous reports were submitted. Changes to population, building square usable footage, travel distances, and floors served shall be reflected in the revised summary report.
2. Drawings showing the approximate locations and dimensions of equipment. Machine room layouts shall reflect equipment dimensions for the "worst case" pre-approved products and their resulting clearances.

### B. Design Development

1. Floor plans showing final locations and dimensions of equipment, machine rooms, hoistways (including minimum and design overhead dimensions), and pit dimensions.
2. Floor plans showing power, lighting, telephone, and HVAC provisions relating to the elevator installation.

### C. Intermediate Submission

1. The initial draft of the project specifications.
2. Sufficiently developed working drawings as follows:
  - a. Floor plans updated to indicate corrections and developments since the initial Design Development Submittal.
  - b. Machine room details.
  - c. Hoistway and hoistway entrance details.
  - d. Hoistway vent details.
  - e. Pit details, including pit ladder or door.

### D. Construction Documentation

1. Completed plans, sections, elevations, and details as mentioned above. Incorporate all corrections required by the University and Consultant.
2. The final draft of the project specifications. All related work shall be listed in Division 14 and identified as "Related Work Specified Elsewhere." Each item of related work shall identify the specification section in which it can be located.

END OF SECTION

# USC DESIGN GUIDELINES

## 14 3000 ELEVATOR DEVELOPMENT OF CONSTRUCTION DOCUMENTS

### PART 1 GENERAL

#### 1.1 SPECIFICATION FORMAT

- A. Specifications shall be produced according to the CSI division format. Each page shall be numbered, dated, and properly identify the project.
- B. Specifications must be carefully coordinated with drawings to ensure that everything shown on the drawings is specified. The specifications prepared for each project shall be job specific. Information not pertaining to the specific project shall not appear.

#### 1.2 DRAWING FORMAT

- A. Deliverables to USC shall be one reproducible vellum and three blueprints 30" x 42" format. For addendums, design sketches and other miscellaneous submittals 11" x 17" or 8.5" x 11" formats are acceptable. Drawings should be prepared using CADD and translatable into common file type such as .DXF for possible future delivery to USC. Drawings units will be imperial (feet and inches). Abbreviations used in drawings shall be listed on drawings. Fonts for typical text shall be 3/32" minimum height ROMANS, drawing titles shall be 3/16" minimum height ROMAND, and sheet titles shall be 1/4" minimum height HLVFILL. Equivalents to these fonts will be acceptable. Minimum drawings included shall be a hoistway, pit and machine room plan and hoistway section for each elevator or core, cab interior elevations and details for each elevator type, sill and entrance details and other details as are necessary for clear delineation of the project. Architectural drawings and consultant drawings for structural, mechanical, electrical and other necessary disciplines shall incorporate and coordinate information contained in the vertical transportation consultant's information package. Revisions shall be clouded with a delta reference to the date of revision.

#### 1.3 RELATED WORK

See Part 3.

#### 1.4 DEFINITIONS

Elevator terms used shall be as defined in the latest edition of the Safety Code for Elevators and Escalators, ASME A17.1.

#### 1.5 QUALITY ASSURANCE

Pre-approved products, model numbers, manufacturers, and installers shall be listed in every Division 14 specification. The following are currently approved:

- A. Approved New Elevator Installers
  - 1. Geared and gearless Traction Elevators:
    - a. Total Access
    - b. Mitsubishi

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- c. Specialized Elevator
  - d. Next Level Elevator
  - e. Excelsior Elevator
  - f. Elevator Etc.
  - g. H & H Elevator
  - h. Consolidated Elevator
  - i. Others as approved in writing by USC
2. Hydraulic Elevators
- a. Total Access
  - b. Mitsubishi
  - c. Specialized Elevator
  - d. Next Level Elevator
  - e. Excelsior Elevator
  - f. Elevator Etc.
  - g. H & H Elevator
  - h. Others as approved in writing by USC
- B. Approved Car Enclosure
- 1. SnapCab
  - 2. City Lift
  - 3. Sterling
- C. Approved Hoistway Entrances
- 1. Swiss Dane
  - 2. City Lift
  - 3. Tyler
  - 4. H & B Elevator
- D. Approved Signal Fixtures
- 1. Pushbuttons:
    - a. Elevator Research Manufacturing (ERM)
    - b. Innovation industries
  - 2. Indicators and Gongs:
    - a. C.E. Electronics
    - b. Telephones by JANUS-PNB-TRE
  - 3. Approved Vertical Bi-Parting Doors:
    - a. Courion



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- b. Peelle
- E. Approved SCR Digital Drives
  - 1. MCE System 12 (or latest addition, subject to USC approval)
- F. Acceptable Hydraulic Controls
  - 1. Motion Control Engineering HMC- Performa (or latest addition subject to USC approval)
- G. Acceptable Hydraulic Valves
  - 1. Maxton
- H. Acceptable Infrared Reopening Device
  - 1. JANUS E200
- I. Acceptable Door Operators

High-speed, heavy duty, master door operator capable of opening doors at no less than 2-1/2 f.p.s. Accomplish reversal in no more than 2-1/2" of door movement. Open doors automatically when car arrives at a floor.

- 1. Acceptable closed-loop door operators:
  - a. M.O.V.F.R by G.A.L.
- J. Approved Microprocessor-based, Group Dispatch, Car and Motion Control Systems (Geared, Gearless)
  - 1. MCE Performa (or latest addition subject to USC approval)

The Quality Assurance section of the specifications shall also list the prevailing local Codes and Authorities as well as the National Elevator Code, ASME A 17. 1. Compliance with the latest editions and supplements of these codes is mandatory. Where conflicts exist, the most stringent requirement shall be adhered to.

- K. Machine Room Less Elevators are not allowed at this time.

### 1.6 DOCUMENT VERIFICATION

- A. Bidders shall be required to review all Contract Documents for compatibility with their respective products. Review shall include structural, architectural, electrical, and mechanical drawings. Should specific exceptions or clarifications develop, these must be submitted at bid time.

### 1.7 SUBMITTALS

The specifications shall dictate the submittals required and when - usually 60 days after award. Division 14 should also reference the Division I requirements for submittals. The following submittals are required on all USC new construction projects:

- A. Scaled or Fully Dimensioned Layout: Plan of pit, hoistway, and machine room indicating equipment arrangement, elevation section of hoistway, details of car enclosures, hoistway entrances, and car/hall signal fixtures.
- B. Design Information: Indicate equipment lists, reactions, and design information on layouts.

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- C. Power Confirmation Sheets: Include motor horsepower, code letter, starting current, full-load running current, and demand factor for applicable motors.
- D. Fixtures: Cuts, samples or shop drawings.
- E. Finish Material: Submit 3" x 12" samples or 12" lengths of actual finished material for review of color, pattern and texture by Architect. Compliance with other requirements is the exclusive responsibility of the Provider. Include, if requested, signal fixtures, lights, graphics, Braille plates and mounting provisions.
- F. The Elevator Contractor shall be required to acknowledge and/or respond to drawing comments within 14 days of return and promptly incorporate required changes due to inaccurate data or incomplete definition so that delivery and installation schedules are not affected. Revision response time shall not be justification for equipment delivery or installation delay.

### 1.8 PERMITS, TESTS AND INSPECTIONS

The Elevator Contractor shall be required to:

- A. Obtain and pay for permit, license and inspection fee necessary to complete the installation.
- B. Perform test required by Governing Authority in accordance with procedure described in ASME A17.2 Inspectors' Manual for Elevators and Escalators in the presence of Authorized Representative.
- C. Supply personnel and equipment for test and final review required by consultant, as indicated in Part 3.

### 1.9 MAINTENANCE

The following forms of elevator preventive maintenance are required on each USC project:

- A. Interim:
  - 1. When one or more elevators are near completion and ready for service, the Purchaser or General Contractor may accept elevators for interim use and place in service before entire installation of all elevators has been completed and accepted.
  - 2. During this period Purchaser or General Contractor may pay a mutually agreed amount per elevator for preventive maintenance. Indicate amount per unit per month with bid.
  - 3. Temporary acceptance form must be acceptable to Purchaser or General Contractor and signed prior to use.
  - 4. User must provide or pay for temporary hoistway and car enclosures; protect installed equipment and finishes; and pay for all cleaning, repairs, and replacement of materials necessary to restore elevator to "as-new" condition prior to final acceptance by USC.
- B. Warranty Maintenance:
  - 1. Provide preventive maintenance and 24-hour emergency call-back service for of one year commencing on date of final acceptance by USC. Systematically examine, adjust, clean and lubricate all equipment. Repair or replace defective parts using parts produced by the Manufacturer of installed equipment. Maintain elevator machine room, hoistway, and pit in clean condition.

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2. Use competent personnel, acceptable to the USC, supervised and employed by the Provider.
3. USC, retains the option to delete cost of warranty maintenance from new equipment contract and remit 12 equal installments directly to Provider during period in which work is being accomplished.

### PART 2 PRODUCTS

Part 2 of the Division 14 specifications shall include an outline of the required equipment followed by a detailed narrative addressing each major component area, required performance levels, and quality level.

The outline or summary section shall identify the type and number of elevators and their specific physical characteristics. At a minimum the following shall be covered:

#### 2.1 SUMMARY

- A. The type or intended usage of elevators shall be clearly defined. For example, "Low-Rise, Geared Passenger Elevators." A separate summary shall be provided for each type of elevator on the project.

NUMBER:	Indicate the quantity of elevators of this type.
CAPACITY:	Indicate the elevator capacity in pounds.
SPEED:	Indicate the elevator speed in feet per minute.
ROPING:	1:1 or 2:1 roping is preferred on all geared installations.
SUPERVISORY CONTROL:	Approved supervisory control systems shall be clearly defined.MCE
OPERATIONALCONTROL:	Approved operational control systems shall be clearly defined.MCE
MOTOR CONTROL:	Approved motor control systems shall be clearly defined. VVVF
POWER CHARACTERISTICS:	Typically 480V, 3-Phase, 60 Hertz. Power characteristics should be carefully confirmed on all modernization projects.
STOPS:	Indicate the number of floors served.
OPENINGS:	Indicate the number of openings served.
FLOORS SERVED:	Provide the names of the floors served.
TRAVEL:	Indicate the overall travel distance.

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PLATFORM SIZE:	Preferably a standard configuration based upon a standard capacity.
MINIMUM INSIDE CLEAR SIZE:	Ensure compliance with Code.
ENTRANCE SIZE:	Minimum of 3'-6" wide x 7'-0" high.
ENTRANCE TYPE:	Single-speed, center opening for passenger elevators; two-speed, side opening for service elevators.
DOOR OPERATION:	Reference Approved Products List.
DOOR PROTECTION:	Infrared curtain units only. Reference Approved Products List. JANUS E200
MACHINE:	Geared or Gearless
MACHINE LOCATION:	Overhead
SAFETY:	Type B only. Provide counterweight safety if occupied space exists beneath pit.
GUIDE RAILS:	Planned steel tees. Guide rails shall be sized to meet bracket spans indicated on drawings.
BUFFERS:	Oil at speeds over 200 f.p.m.
COMPENSATION:	Encapsulated chain at speeds up to 500 f.p.m. Wire rope at speeds above 500 f.p.m. Manufacturer approved pit guide sheaves or rollers shall be provided in all cases.
CAR ENCLOSURE:	Car finishes shall be of durable material. Decorative drop ceilings shall not be used. Lighting shall be flush with canopy and vandal-resistant. Service elevators shall be finished in textured stainless steel. Minimum car height shall be 8'-0" for passenger cars and 10'-0" for service cars. Base car construction shall be of a 14 gauge steel shell and 12 gauge steel canopy. Front returns shall be of 14 gauge stainless steel.
SIGNALS:	By ERM or Innovation only
RESTORATION LIGHTS:	A single hall button riser shall be provided for groups up to three elevators. Single car

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	stations shall be provided. All car and corridor fixtures shall be vandal-resistant, and illuminated L.E.D.s.
POSITION INDICATOR:	Digital with direction arrows at all floors.. Locate as directed by Architect.
HALL LANTERNS:	On all elevators serving three or more landings. Provide with stainless steel faceplate, tamper-proof, and adjustable electronic chime or tone.
IN-CAR LANTERNS:	Can be provided on two-stop units only.
HALL CAR POSITION INDICATOR:	Digital with direction arrows. Provide at ground floor entrance of service elevators only.
COMMUNICATION SYSTEM:	ADA compliant. Self-dialing, vandal-resistant. Push-to-talk, two-way communication system with recall, tracking and voiceless communication.
FIXTURE SUBMITTAL:	Submit brochures depicting Manufacturer's proposed design with bid.
ADDITIONAL FEATURES:	Car and counterweight roller guides – maximum 350 r.p.m. By ELSCO
	Car top inspection station -mount on 4'-0" extension cord
	Firefighters' service, including Phase I, Phase II, and alternate floor return feature. Provide code required instruction engraving. ERM key HW1002
	Standby power transfer (automatic to main floor) with manual override in fire control panel where required by code
	ADA and emergency medical services access and signage
	Stationary car return panels
	Jamb mounted hoistway access switches, top and bottom floor. ERM key J204
	Independent service feature. ERM key J201

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	Platform isolation
	Stop Switch ERM key J202
	Anti-nuisance feature on units serving 6 or more landings
	Security control panel and remote wiring where required
	Firefighters' control panel and remote wiring where required
	Tamper-resistant fasteners for signal fixture faceplates
	Sill support angles
	One year warranty maintenance
	Firefighters' telephone jack where required
	Emergency paging speaker installation where required
	Machine, power conversion unit, and controller sound isolation
	Seismic devices and operation. Provide dual derailment devices and a dual axis seismic switch. Provide seismic safety valves on all hydraulic installations
	Pad buttons and vinyl-covered pads for dormitory passenger elevators
	Prime finish temporary car doors for use during construction
	Card reader provisions where required
	CCTV provisions where required
	Dual-mode operation for swing/service elevators
	Battery pack, vandal-resistant emergency car lighting. Provide separate constant pressure test button in car service

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	compartment. Locate inconspicuously flush in car canopy
	Signage engraving filled with black paint
	No visible company name or logo
	Wiring diagrams, operating instructions, and parts ordering information
	System diagnostic means and instructions
	Non-proprietary (maintainable) control system and diagnostics provisions

### 2.2

#### **MATERIALS**

##### A. Steel:

1. Sheet Steel (Furniture Steel for Exposed Work): Stretcher-leveled, cold-rolled, commercial-quality carbon steel, complying with ASTM A366, matte finish.
2. Sheet Steel (for Unexposed Work): Hot-rolled, commercial-quality carbon steel, pickled and oiled, complying with ASTM A568 and A569.
3. Structural Steel Shapes and Plates: ASTM A7, ASTM and A36.

##### B. Stainless Steel: Type 302 or 304 complying with ASTM A167, with standard tempers and hardness required for fabrication, strength and durability. Apply mechanical finish on fabricated work in the locations shown or specified, (Federal Standard and NAAMM nomenclature), with texture and reflectivity required to match Architect's sample. Protect with adhesive-paper covering.

1. No.4: Bright directional polish (satin finish). Graining directions as shown or, if not shown, in longest dimension.
2. No.8: Reflective polish (mirror finish).
3. Textured: 5WL pattern with .050 inches mean pattern depth with bright directional polish (satin finish).
4. Non-directional, random swirl pattern.

##### C. Bronze: Stretcher-leveled, re-squared sheets composed of 60% copper and 40% zinc similar to Muntz Metal, Alloy Group 2, with standard temper and hardness required for fabrication, strength and durability. Clean and treat bronze surfaces before mechanical finish. After completion of the final mechanical finish on the fabricated work, use a chemical cleaner to produce finish (Federal Standard and NAAMM nomenclature) matching Architect's sample:

1. Polished Bronze: M21-C12-06X, bright-polished bronze, clear-coated (US9) finish with clear-organic lacquer coating recommended by Fabricator.
2. Fine Satin (Brushed) Bronze: M31-C12-06X, fine-satin bronze, clear-coated (US10) with clear-organic coating recommended by Fabricator. Provide graining direction as shown or, if not shown, in longest dimension.

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3. Acid-Etched Pattern: Provide an M21-C12-C5X-06X bright-polished (US9) background selectively acid-etched, matte-textured, custom pattern as shown. Acid selection and dilution (if required) recommended by Fabricator. After final finishing, coat bronze with clear-organic lacquer coating recommended by Fabricator.
- D. Aluminum: Extrusions per ASTM B221; sheet and plate per ASTM B209.
- E. Plastic Laminate: ASTM E84 Class A and NEMA LD3.1, Fire-Rated Grade (GP-50), Type 7, 0.050"  $\pm$  .005" thick; color and texture as follows:
  1. Exposed Surfaces: Color and texture selected by Architect.
  2. Concealed Surfaces: Manufacturer's standard color and finish.
- F. Fire-Retardant Treated Particle-Board Panels: Minimum 3/4" thick backup for natural finished wood and plastic laminate veneered panels, edged and faced as shown, provided with suitable anti-warp backing; meet ASTM E84 Class "I" rating with a flame-spread rating of 25 or less, registered with Local Authorities for elevator finish materials.
- G. Natural Finish Wood Veneer: Standard thickness, 1/40" thoroughly dried conforming to ASME/HPMA HP-1983, Premium Grade. Place veneer, tapeless spliced with grain running in direction shown, belt and polish sanded, book-matched. Species and finish designated and approved by Architect.
- H. Paint: Clean exposed metal of oil, grease, scale and other foreign matter and factory paint one shop coat of Manufacturer's standard rust-resistant primer. After erection, provide one finish coat of Industrial enamel paint. Galvanized metal need not be painted.
- I. Prime Finish: Clean all surfaces receiving a baked enamel finish of oil, grease and scale. Apply one coat of rust-resistant mineral paint followed by a filler coat over uneven surfaces. Sand smooth and apply final coat of mineral paint.
- J. Baked Enamel: Prime finish per above. Apply and bake 3 additional coats of enamel in the selected solid color.
- K. Marble: Refer to appropriate Specification Section.
- L. Carpet: Refer to appropriate Specification Section.
- M. Glass: Laminated safety glass, minimum 9/16" thick, conforming to ANSI Z97.1 and CPSC 16 CFR Part 1201.

### 2.3

#### CAR PERFORMANCE

- A. Speed:
  1. Traction Elevators:  $\pm$  3% of contract speed under any loading condition.
  2. Hydraulic Elevators:  $\pm$  10% of contract speed under a full load up condition.
- B. Capacity: Safely lower, stop and hold up to 125% of rated load.
- C. Stopping Accuracy:
  1. Traction Elevators:  $\pm$  1/4" under any loading condition.
  2. Hydraulic Elevators:  $\pm$  3/8" under any loading condition.
- D. Door Opening Time\*: Seconds from start of opening to fully open:
  1. 3'-6" wide, single-speed, center opening doors:



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- a. Traction: 1.6 seconds.
- b. Hydraulic: 2.1 seconds.
2. 4'-0" wide, single-speed, center opening doors:
  - a. Traction: 1.7 seconds.
  - b. Hydraulic: 2.2 seconds.
3. 3'-6" wide, side opening doors:
  - a. Traction: 2.3 seconds.
  - b. Hydraulic: 3.1 seconds.
4. 4'-0" wide, side opening doors:
  - a. Traction: 2.5 seconds.
  - b. Hydraulic: 3.5 seconds.
5. 4'-6" wide, side opening doors (all elevators): 2.7 seconds.

\*Values based on 7'-0" to 7"-6" high doors. For 7'-6" to 8'-6" high doors, add the following factor to door open and door close time: .5 seconds for widths up to 42" and 1 second for widths over 42".
- E. Door Closing Time: Seconds from start of closing to fully closed: Door closing time shall be adjusted within Code limits. Shop drawings provided by installer shall indicate pertinent weight data and door close time calculations.
- F. Start-to-Stop Motion Time\*: Seconds from start of hoist machine motion until machine motion comes to a complete stop with car level and stopped at next successive floor under any loading condition or travel direction (12'-0" typical floor height; adjust .2 seconds per foot of travel on traction equipment and .5 seconds on hydraulic equipment):
  1. Traction at 200 f.p.m.: 6.5 seconds.
  2. Traction at 350 f.p.m.: 5.6 seconds.
  3. Traction at 450 f.p.m.: 5.2 seconds.

\*Values are based upon 3'-6" wide, center opening doors. If necessary, adjust per D above.
- G. Floor-to-Floor Performance Time\*: Seconds from start of doors closing until doors are 3/4 open (1/2 open for side opening doors) and car level and stopped at next successive floor under any loading condition or travel direction (12'-0" typical floor height; adjust .2 seconds per foot of travel on traction equipment and .5 seconds on hydraulic equipment):
  1. Hydraulic at 100 f.p.m.: 14.0 seconds.
  2. Hydraulic at 125 f.p.m.: 13.0 seconds.
  3. Hydraulic at 150 f.p.m.: 12.5 seconds.
  4. Traction at 200 f.p.m.: 10.0 seconds.
  5. Traction at 350 f.p.m.: 9.1 seconds.
  6. Traction at 450 f.p.m.: 8.7 seconds.

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\*Values are based upon 3'-6" wide, center opening doors. If necessary, adjust per D above.

### H. Ride Quality (Geared Traction):

1. Horizontal acceleration within car during all riding and door operating conditions: Not more than 15 mg peak to peak in the 1-10 Hz range.
2. Acceleration and Deceleration: Smooth constant and not more than 3 feet/second/second with an initial ramp between 0.5 and 0.75 second.
3. Sustained Jerk: Not more than 6 feet/second/second squared.
4. Airborne Noise: Measured noise level of elevator equipment and its operation shall not exceed 50 dBa in elevator lobbies and 60 dBa inside elevator car under any condition including door operation and car ventilation exhaust blower on its highest speed.

## 2.4 GROUP PERFORMANCE

### A. System-Response Time: Meet the following criteria during any 60-minute peak period as measured by duration of all hall call registration times:

1. System-Response Time: Not more than 20 seconds.
2. Hall Calls Answered within 30 Seconds: Not less than 75%.
3. Hall Calls Answered within 60 Seconds: Not less than 98%.

Base above performance on not more than 250 hall calls being registered within 60 minute period, all cars in group operation during test period, and floors not served by all elevators not included in test.

## 2.5 OPERATION

All operational and group dispatch control systems shall be microprocessor-based. Groups of three cars or more shall be provided with artificial intelligence and logic features. The following strategies may be used on USC projects, where applicable:

### A. Two-stop collective (single cars serving two landings):

1. Operate elevator without attendant from buttons in car and located at each landing. Dispatch car when the car or hall button for a landing is pressed. Retain calls registered when car is in transit, allow time for passenger transfer, then dispatch to another hall call.
2. Illuminate pushbutton when call is registered; extinguish light when call is answered.

### B. Selective Collective (single car serving more than two landings):

1. Operate elevator without attendant from buttons in car and located at each floor. When car is available, automatically start car and dispatch it to floor corresponding to registered car or hall call. Once car starts, respond to registered calls in direction of travel in order floors are reached.
2. Do not reverse car direction until all car calls have been answered or until all hall calls ahead of car and corresponding to direction of car travel have been answered.
3. Slow car and stop automatically at floors corresponding to registered calls, in the order in which they are approached in either direction of travel. As slowdown is initiated for a

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hall call, automatically cancel hall call. Cancel car calls in same manner. Hold car at arrival floor an adjustable time interval to allow passenger transfer.

4. Answer calls corresponding to travel direction of car unless call in the opposite direction is highest or lowest call registered. Illuminate appropriate button to indicate call registration. Extinguish light when call is answered.
- C. Duplex Selective Collective (two-car groups - hydraulic):
1. Operate elevators without attendants from buttons in cars and located at each floor. When cars are available, park one car at main floor ("home" car). Park other car where last used ("free" car).
  2. Respond to car calls and hall calls above main floor using the "free" car. Once a car has started, respond to registered calls in the direction of travel and in the order the floors are reached.
  3. Do not reverse car direction until all car calls have been answered, or until all hall calls ahead of the car and corresponding to the direction of car travel, have been answered.
  4. Slow cars and stop automatically at floors corresponding to registered calls, in the order in which they are approached in each direction of travel. As slowdown is initiated, automatically cancel hall call. Cancel car calls in the same manner. Hold car at arrival floor an adjustable time interval to allow passenger transfer.
  5. Answer calls corresponding to direction in which car is traveling unless call in the opposite direction is the highest (or lowest) call registered.
  6. When the free car is clearing calls, start home car to respond to:
    - a. A call registered on home car buttons.
    - b. An up hall call registered below free car.
    - c. An up or a down call registered above free car while free car is traveling down.
    - d. A hall call when free car is delayed in its normal operation for a predetermined period.
  7. When both cars are clearing calls, stop only one car in response to any registered hall call. Return the first car to clear its calls to main floor. Should last service required bring both cars to main floor, the first arriving car becomes the free car.
  8. Illuminate floor button to indicate call registration. Extinguish light when call is answered.
  9. Answer lower floor calls with the "home" car unless free car is parked at floor where the call occurs. If no car is parked at main level, answer calls below main floor using the first car traveling down. Do not stop cars traveling to or from levels below main floor at main floor unless there are calls registered for service at that floor.
- D. Group Automatic (two-car traction groups and all groups of three cars or more):
1. Approved microprocessor-based, group dispatch with Artificial Intelligence and Fuzzy Logic. As follows including, as a minimum, provide the features described hereafter.
    - a. Operate elevators as a group capable of balancing service and provide continuity of group operation with one or more cars removed from the system.

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- b. Operate elevators from buttons located at each floor and in each car. Slow down and automatically stop cars at landings corresponding to registered calls. Make stops at successive floors for each direction of travel irrespective of order in which calls are registered except when bypassing hall calls to balance and improve overall service; stop only one car in response to particular hall call. Simultaneous to initiation of slowdown of a car for a hall call, cancel that call. Render hall button ineffective until car doors begin to close after passenger transfer. Cancel car calls in the same manner. Give priority to coincidental car and hall calls in car assignment.
- c. Operate system to meet changing traffic conditions on a service demand basis. Include provisions for handling traffic which may be heavier in either direction, intermittent or very light. As traffic demands change, automatically and continually modify group and individual car response to provide the most effective means to handle current traffic conditions. Hall calls shall receive immediate assignment to individual cars and hall lantern shall sound and illuminate. Hall lantern shall sound again and illumination shall pulse just prior to car arrival. Give priority to coincidental car and hall calls in hall call assignment and accomplish car direction reversal without closing and reopening doors.
- d. Use easily re-programmable system software. Design basic algorithm to optimize service based on equalizing system's response to registered hall calls and equalizing passenger trip time at shortest possible time.
- e. Serve floors below main floor in a manner which logically minimizes delay in passing or stopping at main floor in both directions of travel. Provide manual means to force a stop at the main floor when passing to or from lower levels.
- f. Control systems shall include one or more of the following approaches to maximizing the interfloor traffic performance of the group of elevators and reducing the number of long wait calls.
  - 1) Incorporate fuzzy logic type rule sets in an expert system rule base. Provide a short term learning function and a knowledge base of predicted traffic patterns and car movements.
  - 2) A long term learning function that utilizes historical building traffic patterns for assignment and pre-positioning of cars. Minimize stops by inferring likely traffic patterns and arrival/departure rates at different floors during different times of the day.
  - 3) A destination hall call registration system that anticipates traffic demands before they occur.
- g. Required Failure Features:
  - 1) Dispatch Protection: Backup dispatching shall function in the same manner as the primary dispatching.
  - 2) Delayed Car Removal: Automatically remove delayed car from group operation.
  - 3) Position Sensing: Update car position when passing or stopping at each landing.
  - 4) Hall Button Failure: Multiple power sources for button risers.

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- 5) Duplicate communication link; all group and individual car computers.

### 2.6 ADDITIONAL REQUIRED CONTROL FEATURES -TRACTION ELEVATORS

- A. Load weighing device to initiate hall call bypass, anti-nuisance feature and initiate hoist motor pre-torque.
- B. Anti-nuisance feature.
- C. Independent service.
- D. Firefighter's Service: Provide Phase I, Phase II, and alternate floor return feature on all hydraulic and traction elevators.
- E. Dual-Mode Operation for swing/service elevators.
- F. Standby Power Transfer where applicable.
- G. System Monitoring on groups of three or more.
- H. Security systems where dictated by USC Facilities Planning and Management. Security systems may include:
  1. Floor lock-off switches.
  2. Car button actuated systems.
  3. Card/ proximity reader systems.
  4. Camera provisions.
- I. Motion Control. Traction elevator motion control systems shall be microprocessor-based DC variable voltage or AC variable voltage, variable frequency with digitally encoded closed-loop velocity feedback.
- J. Door Operation. Provide differential timing feature. Door dwell time shall be adjustable from 3-5 seconds for car calls and 5-8 seconds for hall calls. Provide nudging feature set between 20 and 30 seconds.

### 2.7 MACHINE ROOM EQUIPMENT

- A. Geared Machine.
  1. Worm geared traction type with motor, brake, gear, drive shaft, deflector sheave, and gear case mounted in proper alignment on an isolated bed plate. Provide blocking to elevate deflector sheave above machine room floor.
  2. Provide Hollister Whitney Rope Gripper of correct model sized for car weight and speed
  3. Provide a direct drive, digital, closed-loop velocity encoder oil hoist machine.
  4. Provide hoist machine drip pans to collect lubricant seepage.  
  
Provide machine bedplate mounted deflector sheave A-frame and/or supporting steel beams, and fastenings to mount deflector sheaves to building structure. Provide minimum 16-gauge easily removable sheet metal closures in wall opening around machine between the machine room and hoistway on basement or semi-basement applications.
- B. Pump Unit. Assembled unit consisting of positive displacement pump, induction motor, master-type control valves combining safety features, holding, direction, bypass, stopping and manual lowering functions, shut off valve, oil reservoir with protected vent opening, oil gauge and outlet strainer, drip pan and connections all mounted on isolating pads. Provide thermal unit or

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comparable means to maintain oil at operating temperature. Enclose with removable sheet steel panels lined with sound-absorbing material. Provide secondary containment with monitoring. Submersible pumps are acceptable depending on location and usage.

- C. Solid-State Power Conversion and Regulation Unit. Traction elevators shall be provided with silicon controlled rectifiers. Generator field control is not acceptable.
- D. Starting Switches. Hydraulic elevators shall be provided with SCR (Nordic) soft start.
- E. Encoder. Digital encoders shall provide positioning on all traction equipment.
- F. Hydraulic Piping and Oil. Provide piping, connections and oil for the system. Buried piping shall be secondarily contained and monitored with watertight Schedule 40 PVC sleeves between elevator machine room and pit. A minimum of two sound isolation couplings shall be provided between the pump unit and oil line and the oil line and jack unit. Provide pipe stands or hanger's as required.
- G. Controller. See pre-approved product listing. All controllers shall carry a UL or CSA label.
- H. Isolation and Noise Reduction. All equipment shall be physically and electronically isolated from the building. Reference should be made to the acoustical section of the specifications.

### 2.8

#### HOISTWAY EQUIPMENT

- A. Guide Rails. Planed steel T-sections suitable for the application, car weight, counterweight, and seismic reactions, with brackets for attachment to building structure. Provide car rail backing and intermediate counterweight tie brackets to meet Code requirements. Provide double bracketing, i.e. top and bottom of floor beam.
- B. Sheaves. Machined grooves with scaled bearings. Provide mounting means to machine beams, machine bed plate, car and counterweight structural members, etc.
- C. Hydraulic Cylinder, Plunger, and Well Hole.
  - 1. Cylinder: Seamless steel pipe. Design head to receive unit type packing and provide means to collect oil at cylinder head and automatically return to oil reservoir. Provide secondary containment and monitoring provisions, per C.C.R. Title 23.
  - 2. Plunger: Polished seamless steel tubing or pipe. If plunger length exceeds 24', provide two or more sections not exceeding 16' in length, or coordinate installation of longer unit at the job site. Join section by internal threaded couplings. Multiple section jack units shall be factory polished while assembled and marked for proper future reassembly. Isolate plunger from car sling.
  - 3. Well Hole, Casing: Well hole is to be provided by elevator contractor. No extra will be allowed for unforeseen conditions of any kind or spoil removal. Install steel outer casing minimum 18" diameter. Install watertight PVC sleeve for secondary containment over jack assembly prior to insertion into the outer casing. Extend PVC sleeve through pit floor slab to underside of jack support beams and seal with non-permeable membrane. I.D. of PVC sleeve shall be capable of containing 110% of system capacity. Seal well opening at the pit floor with hydraulic quick setting cement. Provide vision ports, per C.C.R. Title 23.
- D. Seismic Safety Valve. Provide on all hydraulic installations. Conform to ASME A17.1, Rule 2410.6.
- E. Electrical Wiring and Wiring Connections.
  - 1. Conductors and Connections: Copper throughout with individual wires coded and connections on identified studs or terminal blocks. Use no splices or similar connections in wiring except at terminal blocks, control compartments, junction boxes, or condulets. Provide 10% spare conductors throughout. Run spare wires from car connection points to individual elevator controllers in the machine room. Provide four pairs of spare shielded communication wires in addition to those required to connect specified items. Tag spares in machine room.

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2. Conduit: Painted or galvanized steel conduit and duct. Conduit size, 1/2" minimum. Flexible conduit not to exceed 36" in length. Flexible heavy-duty service cord may be used between fixed car wiring and car door switches for door protective devices.
  3. Traveling Cables: Type ET flame and moisture resistant outer cover. Prevent traveling cable from rubbing or chafing against hoistway or equipment within hoistway. Provide 2 RG-59 coaxial CCTV cables within traveling cable from car controller to car top.
  4. Auxiliary wiring: Connect smoke sensors, emergency telephone system, firefighters' phone jack, paging speaker, CCTV, card reader, intercom in each car controller in machine room.
- F. Hoistway Entrances. Entrance assemblies shall be provided with U.L. fire labels.
1. Frames. Hollow metal, bolted flush head to jamb connection assembly fabricated from not less than 14-gauge material. Permanently attach, rear mounted, cast, Arabic floor designation plates at 60" above finished floor on both side jambs. Provide main egress landing plates with "Star" designation. For designated emergency elevator, provide rear mounted, cast "Star of Life" designation plate at height of 78"-84" above finished floor on both side jambs. Braille indications shall be to the left of Arabic floor designation. Provide 14 gauge subframe for special Architectural overlay finishes. Size frames and doors at least 4" wider and 2" higher than clear opening dimensions.
  2. Door Panels-Car and Hoistway. Panels: 16-gauge steel, sandwich construction without binder angles. Provide leading edges of center-opening doors with rubber astragals. Provide a minimum of two gibs per panel, one at leading and one at trailing edge with gibs in the sill groove their entire length of travel. Construct doors higher than 7'-0" with interlocking, stiffening ribs.
  3. Sills. Extruded aluminum. Sill support angles shall be provided and installed by the Elevator Contractor.
  4. Fascia. Fascia, toe guards, and hanger covers shall be hoistway width and fabricated of 14 gauge material. Paint with flat black enamel.

### 2.9

#### CAR EQUIPMENT

- A. Car Frame. Welded or bolted steel channel construction.
- B. Platforms. Construct of steel or wood which is fireproofed on the underside.
- C. Guide Shoes. ELSCO spring loaded for car and counterweight.
- D. Door Operators. Reference approved products listing.
- E. Door Reversal Devices. Reference approved products listing.
- F. Fixtures. Reference approved products listing. All Code required and specified engraving shall be provided. Photo etching and/or stick-on signage will not be accepted.
- G. Service Cabinet. Provide a lockable service cabinet with Inspection Certificate Frame on face of door. Cabinet shall contain:
  1. Inspection switch.
  2. Light switch.
  3. 3-speed exhaust blower switch.

## USC DESIGN GUIDELINES

4. Independent service switch.
  5. Constant pressure test button for battery pack emergency lighting.
  6. 120-volt, AC, GFCI protected electrical convenience outlet.
  7. Card reader override switch where applicable.
  8. In Car Inspection Operation.
- H. Car Top Control Station. Provide with 4'-0" long, permanently attached, extension cord for remote operation.
- I. Work Light and Duplex Plug Receptacle. CFCI protected outlet top and bottom of elevator car. Include on-off switch and grounded metal lamp guard.
- J. Communication System by JANUS.
1. Push to Talk, "two-way communication instrument in car with automatic dialing, tracking and recall features with shielded wiring to car controller in machine room. Provide dialer with automatic roll over capability with minimum four numbers.
    - a. "Push to Talk" button or adjacent light jewel shall illuminate and flash when call is acknowledged. Button shall match floor pushbutton design. Provide uppercase "Push to Call," "Help on the Way" engraved signage Sans Serif or simple Serif type.
    - b. Provide "Push to Talk" button tactile symbol engraved signage and Braille adjacent to button.
  2. Firefighters' telephone jack in car and Firefighters' panel, with four shielded wires to machine room junction box. Jack bezel shall match adjacent controls.
  3. Install remote speaker provided by Life Safety Contractor behind front return panel with shielded wiring to machine room junction box.
- K. Car Enclosure. Finish details shall be shown on Architectural Drawings.
1. Shell. 14 gauge furniture steel with baked enamel finish. Service elevator pan sections shall not exceed 18".
  2. Canopy. 12 gauge furniture steel with baked enamel finish.
  3. Front Return Panels. Stationary type of 14 gauge stainless steel or textured stainless steel.
  4. Transom. 14 gauge stainless or textured stainless steel running full enclosure width.
  5. Base. Baked enamel or stainless steel. All elevators shall be provided with base ventilation. Passenger elevator vent slots shall be hidden.
  6. Ventilation. Three-speed, Morrison Products, Model AA exhaust blower isolated from canopy on rubber grommets. Morrison OE acceptable in certain application. Nylube is an acceptable alternate.
  7. Lighting. Fluorescent fixtures Dual T\* type, flush mounted in canopy with protective diffuser and steel guard over fixtures on car top.
  8. Handrails. Meet ADA requirements for grab bars. Service elevators shall also be provided with a 4" x 3/8" solid stainless steel guard bar 8" above car floor.



## USC DESIGN GUIDELINES

2.10

### HALL CONTROL STATIONS

- A. Pushbutton Stations. Faceplates shall be flush with surrounding surfaces. Buttons shall be vandal-resistant (see pre-qualified products) and meet the requirements of CBC Title 24. Inconspicuous pushbutton risers shall also meet CBC Title 24 and include freight service jewels. Provide with L.E.D. illumination.
- B. Hall Lanterns. Indicators shall be no less than 2-1/2" in their smallest dimension. Illumination shall be via L.E.D. clusters. Electronic chimes shall be provided. Double gong and illumination is required when announcing down direction travel. Sound level shall be adjustable from 20-80 dBA. Provide advanced notification to comply with ADA corridor call notification time. Traction groups of three or more cars shall be provided with predictive lanterns.
- C. Firefighter's Control Panel. Locate in building fire control room. Fixture faceplate, No. 4 brushed finish stainless steel, including the following features:
  - 1. Car position and direction indicator (digital-readout or color VGA display type). Identify position indicator with car number.
  - 2. Indicator showing operating status of elevator.
  - 3. Wiring to panel. Conduit from closest elevator hoistway of each group by others.
  - 4. Manual car standby power selection switch and power status indicator.
  - 5. Firefighters' telephone jack, where applicable.
- D. Machine Room Interactive Device. Provide a control panel and color LED monitor with the capability to activate display and monitor the following functions. Provide conduit and wiring to panel. Provide keyboard and printer.
  - 1. On/off means to place elevator in our out of service. When placed in "off" position, return elevators to nonstop to designated floor and park with doors open.
  - 2. Car operating on normal standby power
  - 3. Car position and direction of travel.
  - 4. Car calls.
  - 5. Hall calls.
  - 6. Door status.
  - 7. Delayed car.
  - 8. Load weigh and by-pass.
  - 9. Car to lobby feature.
  - 10. Car in/out of service.
  - 11. Seismic operation.
  - 12. Secured floor access.
  - 13. Distress signal.
  - 14. Secured after-hours split bank operation.
  - 15. Card reader override.

# USC DESIGN GUIDELINES

## PART 3 EXECUTION

### 3.1 SITE CONDITION INSPECTION

- A. Elevator Contractor shall verify that site conditions conform to project requirements prior to beginning work.

### 3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. The Elevator Contractor shall be provided with suitable storage at the job site. Storage area shall be secure and protect stored equipment from damage.

### 3.3 INSTALLATION

- A. Equipment shall be installed per Manufacturer's instructions, code, specifications, and approved submittals. Installed equipment shall be easily removable for maintenance and repair. Any damage occurring during construction shall be repaired.

### 3.4 FIELD QUALITY CONTROL

- A. Work at the job site will be checked during construction. Full cooperation with reviewing personnel is mandatory. Accomplish corrective work required prior to performing further installation. Have Code Authority acceptance inspection performed and complete corrective work.

### 3.5 ADJUSTMENTS

- A. Install rails plumb and align vertically with tolerance of 1/ 16" in 100'-0". Secure joints without gaps and file any irregularities to a smooth surface.
- B. Static balance car to equalize pressure of guide shoes on guide rails.
- C. Lubricate all equipment in accordance with Manufacturer's instructions.
- D. Adjust motors, power conversion unit, brake, controllers, valves, pumps, leveling switches, limit switches, stopping switches, door operators, interlocks and safety devices to achieve required performance levels.

### 3.6 CLEANUP

- A. Keep work areas orderly and free from debris during progress of project. Remove packaging materials on a daily basis.
- B. Remove all loose materials and filings resulting from work.
- C. Clean machine room equipment and floor.
- D. Clean hoistways, car, car enclosure, entrances, operating and signal fixtures.

### 3.7 ACCEPTANCE INSPECTION AND TESTS

- A. General: Furnish labor, materials, and equipment necessary for tests. Notify Consultant 5 days in advance when ready for final review of elevator unit or group. Final acceptance of installation will be made only after all field-quality control reviews have been completed, identified deficiencies have been corrected, all Owner's information and certificates have been received, and the following items have been completed to satisfaction of Purchaser and Consultant.

## **USC DESIGN GUIDELINES**

1. Workmanship and equipment comply with specification.
  2. Contract speed, capacity, floor-to-floor, and door performance comply with specification.
  3. Performance of following are satisfactory:
    - a. Starting, accelerating, running
    - b. Decelerating, stopping accuracy
    - c. Door operation and closing force
    - d. Equipment noise levels
    - e. Signal fixture utility
    - f. Overall ride quality
    - g. Performance of door control devices.
    - h. Operation of Phase I and II Firefighters' Operations
    - i. Operations of Standby Power transfer Operations
    - j. Operations of special security operation and floor lock-off provisions.
  4. Test Results:
    - a. In all test conditions, obtain specified speed, performance times, stopping accuracy without re-leveling, and ride quality to satisfaction of the Owner and Consultant.
    - b. Temperature rise in motor windings limited to 500 Celsius above ambient. A full capacity, 1-hour running test, stopping at each floor for 10 seconds in up and down directions, may be required.
- B. Performance Guarantee: Should tests reveal defects, poor workmanship, variance or noncompliance with requirements of specified Codes and/or ordinances, or variance or noncompliance with the requirements of specification, complete corrective work to satisfaction of Purchaser and Consultant at no cost:
1. Replace equipment that does not meet Code or specification requirements.
  2. Perform work and furnish labor, materials and equipment necessary to meet specified operation and performance.
  3. Perform and assume cost for retesting required by Governing Code Authority, Purchaser and Consultant to verify specified operation and/or performance.
- C. Field Review Scheduling: Schedule progress and final equipment reviews with Consultant. Reply promptly, in writing, to corrective work indicated on Consultant's progress and/or final review reports, indicating status, schedule for completion, and questions. Consultant anticipates scheduled appointments will be met. Contract price will be reduced to reimburse Consultant at normal billing rates for appointments not kept, or for additional follow-up reviews required due to gross non-compliance with previous review requirements.

### **3.8 INSTRUCTION TO USC PERSONNEL**

- A. The following instruction requirements will apply to all equipment installed at USC where technologies or equipment new to the USC maintenance staff is being provided. The

## USC DESIGN GUIDELINES

depth of, and need for, instruction must be confirmed and adjusted by the USC facilities department prior to issuance of bid documents. Where required, the following training shall be provided:

1. Training During Final Adjustments: USC may assign a maximum of two (2) USC elevator mechanics to observe during the final adjustment of one of each type of elevator. Elevator Contractor's adjusters shall explain the procedures for adjusting the elevator and answer all questions.
2. Training During the Warranty Period:
  - a. Elevator Contractor's adjusters and service personnel, while troubleshooting, adjusting or repairing during the warranty period, shall provide training and answer Questions regarding the procedures used.

### 3.9

#### **OWNER'S INFORMATION, MAINTENANCE MATERIALS AND TOOLS**

- A. General: Within thirty (30) days following final acceptance of the elevator installation, provide all wiring diagrams, written in formation, supplemental data, spare parts and diagnostic tools necessary for proper maintenance and adjustment of the equipment, including the following (Materials must be job-specific for this project.):
- B. Wiring Diagrams:
  1. Provide two (2) copies and one (1) mylar reproducible transparency of all wiring diagrams, including straight-line wiring diagrams of all "As Built and Installed" elevator electrical circuits, complete with an index of the location and function of all components. NOTE: Mylar reproducible shall be Photographic Grade, 5 mil thickness, matted both sides and printed on back side.
  2. Leave ODC (1) complete set of "final" corrected installation diagrams and adjustor's wiring dope sheets on the job, for each unit.
- C. Shop Drawings: Provide two (2) copies of all final corrected construction and installation drawings.
- D. Operation and Maintenance (O&M) Manuals: Provide three (3) neatly bound and indexed sets of O&M manuals containing the following:
  1. Sequence of operation and/or flow charts of the motion and supervisory control panels and related operating equipment. Include logic diagrams for all individual and group microprocessors.
  2. Operation and maintenance instructions, consisting of detailed application data and instructions for all equipment components, including car, corridor and remote signal/control fixtures.
  3. Lubrication program, including recommended procedures and grades of cleaners and lubricants to be used.
  4. Parts catalogs for all replaceable parts, including ordering forms and instructions. NOTE: If a given component is made up of smaller parts, the smaller parts shall also be clearly identified by number.
  5. Summary of contract data for each type of equipment furnished, including quantities and part numbers.

## USC DESIGN GUIDELINES

6. Step-by-step installation and adjusting procedures, as used by equipment manufacturers and installer's field personnel, for each type of equipment furnished. This shall include, but not be limited to, complete data and settings for the following:
  - a. Motion controllers:
    - 1) Power conversion and drive unit adjustments, including relay air gaps, current operated relays, overload relays, timed circuits, acceleration and deceleration patterns and all other field-adjustable settings.
    - 2) Overload relays, timed circuits, and all other field-adjustable settings.
  - b. Dispatching controller: Electronic devices, timed circuits, etc., including data and procedure to change field-programmable microprocessor settings.
  - c. Motors: Air gap, compounding, neutral setting and all other necessary adjustments.
  - d. Machine brake: Shoe clearance, core clearance, brake switch, and all other adjustments necessary to give a satisfactory functioning brake.
  - e. Selectors, encoders, tach generators, etc.
  - f. Governor: Over-speed switch and jaw trip settings, rope pull-through adjustment.
  - g. Hoistway switches, inductors, transducers, vanes, cams, etc.
  - h. Terminal landing slow-down device.
  - i. Leveling/re-leveling units.
  - j. Load weighing device: Settings and load compensation adjustments.
  - k. Safeties: Clearance to rails, releasing carrier pull-out in pounds and adjustment of safety-operated switch.
  - l. Guide shoes: Roller guide spring tension and stop settings.
  - m. Door operator: Door operator motor, control switches, cams, rheostats, potentiometers and resistors.
  - n. Car and Hoistway doors: Door closers, door and gate locks, clutches or bayonets, pick-up and drive rollers, door unlocking cam, and car door restrictors.
  - o. Door protective devices: Focusing, testing, adjusting and maintenance procedures.
  - p. Communications, annunciating, monitoring and security systems.
  - q. Pump flow and leveling control valves, relief valves and jack packing gland.
- E. Supplemental Data: The following supplemental data will be required by USC for all projects:
  1. List of necessary tools, instruments and other equipment used in the adjusting procedure, including the techniques for incorporating them in procedures.
  2. Final adjusting data for each elevator unit, including settings for the following:
    - a. Load compensating switches, in pounds.
    - b. Selectors/encoders.

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- c. Brakes: Shoe running clearance and brake coil current.
  - d. Hostway switches, inductors, transducers, etc.
  - e. Door operator control switch settings.
  - f. Safety device: Full-load, full-speed test data.
  - g. Full-load starting and running current.
  - h. Current settings of current-operated relays.
  - i. Motor field resistance settings.
  - j. Timers: Time delay settings, including method and equipment needed to program microprocessor.
  - k. Electronic power supply voltages necessary for correct functioning of equipment and from where measured.
3. During the warranty period and for a period of not less than two (2) years following expiration of warranty, provide USC with any and all supplementary bulletins or correspondence, issued by either the equipment manufacturer, supplier or installer, relative to any improved replacement parts and any revised procedures for maintenance, trouble shooting and adjustment all any and all equipment installed.
  4. Provide any and all additional data required or requested by USC to facilitate equipment maintenance and adjustment.
- F. Maintenance Materials:
1. Expendable parts: The Elevator Contractor shall provide one or more secure metal cabinets containing expendable parts normally required for maintenance and repairs during the warranty period. Locate cabinet(s) in machine room(s) as directed by USC's Representative. All parts utilized for warranty repairs shall be promptly replaced by the Elevator Contractor. All parts utilized for maintenance or repairs not covered by warranty shall be promptly replaced by USC. Parts cabinet(s) and all parts contained therein shall become property of USC and shall not be removed at the expiration of the warranty period. As a minimum, provide the following items:
    - a. One (1) set of renewal contacts and operating coil for each type of motor starter and main contactor installed.
    - b. Two (2) control relays of each type and voltage installed.
    - c. One (1) complete set of hoist motor brushes for each type installed.
    - d. Ten (10) fuses of each type and size installed.
    - e. One (1) control circuit board of each type and part number installed.
    - f. One (1) set of backup PROMs, programmed for each group supervisory controller and for each individual elevator unit.
    - g. One (1) set of pump unit drive belts of each size and type installed.
    - h. Any other parts required for prompt replacement.
  2. Replacement Parts: The Elevator Contractor shall maintain the following parts in a warehouse within 50 miles of the USC campus.

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- G. Maintenance Tools and Software Documentation: Provide all tools designed specifically for tasks associated with the examination, maintenance, trouble shooting, repair, and adjustment of the elevator equipment installed, which are not readily available through normal purchasing channels.
1. Flash Drives with software programs used for each group supervisory controller and for each individual elevator unit.
  2. Special tools and software documentation shall become the property of USC. NOTE: If individual microprocessor or group supervisory diagnostic equipment and tools are not available for sale, Elevator Contractor shall quote USC on lease of this equipment. Terms of lease must be acceptable to USC. Quote as a separate item.

END OF SECTION

# USC BASIS OF DESIGN

## 21 0000 FACILITY FIRE SUPPRESSION

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Sections 10 52 00 and 28 31 00.
- C. All individuals and companies who propose to engage in the design, installation, or alteration of fire sprinkler systems and private underground fire lines and hydrant systems are subject to the requirements of this design guide.
- D. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X		X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) When sprinkler protection is required in a structure, sprinklers shall be provided throughout 100% of the structure. Exceptions: For minor accessory uses (i.e., trash chutes, spray booths, dumpsters, coolers, etc.)
    - b) Sprinkler protection shall be installed in any area where an obstruction from the overhead protection, exceeding four feet by four feet is created (length and width) for standard sprinklers.
    - c) Alternate fire protection does not exempt required fire sprinkler protection. (Alternate fire protection may be used in conjunction with sprinklers in specific applications).
    - d) In building upgrades or remodels that require fire protection system materials to be abandoned, all non-used materials and equipment shall be removed.
    - e) To ensure that sprinkler systems installed in any structure and underground fire system installations will provide a satisfactory level of life and property safety
    - f) This design guide will apply to all sprinklered structures including but not limited to industrial, commercial, multi-residential (R-1) and private underground fire lines and hydrant systems. This design guide shall be used in conjunction with NFPA 13 and 13R and other applicable codes and standards.
    - g) All sprinkler systems and private hydrant systems shall be designed and installed in accordance with the California Building and Fire Codes and NFPA 13. If applicable and approved, a Nationally Recognized Standard



## USC BASIS OF DESIGN

- may be used. This design guide outlines the procedures to be followed when submitting plans and defines the University's requirements for installations that may be more restrictive or not found in existing codes.
- h) The system shall fully comply with the currently adapted codes and standards, if applicable.
  - i) Plans for sprinkler systems shall be submitted to USC Engineering Services before submitting to Los Angeles Department of Building and Safety/Los Angeles City Fire Department.
  - j) All plans shall include a completed Fire Flow obtained within one year of the submittal date. Information shall include: location of the hydrants flowed and gauged, static pressure, residual pressure, size of orifice, pitot reading, observed flow, date and time of test and backflow prevention requirements.
  - k) All notes and details shall be incorporated onto the original drawings and printed.
  - l) The following notes shall be on the sprinkler plans:
    - 1) The fire protection contractor will provide the University with the necessary instruction manuals for the upkeep of the system.
    - 2) Only new sprinklers shall be employed in the installation of the sprinkler system.
    - 3) The system shall only employ the use of approved materials and devices.
    - 4) Fire protection plans shall be approved prior to the installation of any pipe. A set of approved plans shall be maintained at all times at the job site.
    - 5) System piping shall be hydrostatically tested at 200 psi for two hours or at 50 psi above the maximum system operating pressure, whichever is greater.
    - 6) All valves and fire department connections shall have permanently affixed signs, indicating their function.
    - 7) A stock of spare sprinklers of each style, type and temperature rating along with a sprinkler wrench shall be located at the main riser
    - 8) Welding shall be performed per NFPA 13 requirements.
    - 9) Automatic sprinkler systems shall be supervised.
  - m) The following information shall be provided on the plans:
    - 1) Name of owner or occupant
    - 2) Location, including street address and city
    - 3) Installing contractor's name, address, telephone number, license type and number
    - 4) Ceiling/roof construction details, including the spacing of members
    - 5) Full height cross section, to include mezzanine areas or difficult to understand areas
    - 6) Location of rated and full height walls
    - 7) Location of partitions
    - 8) Occupancy class of each room or area to determine the proper hazard classification
    - 9) Location and size of concealed spaces and all unsprinklered areas
    - 10) Size of city main and if circulating or dead-end
    - 11) Elevations of tank, water supply, pump and structures as they relate to each other, as applicable
    - 12) Location, number of inlets and size of the fire department connection

## USC BASIS OF DESIGN

- 13) Location of closest public fire hydrant to the fire department connection
  - 14) All sources of water supply
  - 15) Make, model, sprinkler identification number (S.I.N.), response type, temperature rating and nominal orifice size ("K" factor) of all sprinklers.
  - 16) Total square footage of building
  - 17) Total square footage per riser per floor
  - 18) Total sprinkler count by style
  - 19) Make, type and model of valves
  - 20) Location of exterior alarms
  - 21) Pipe make, size, class, type, internal diameter and C-factor.
  - 22) Nominal pipe size and cutting length of pipe (or center to center)
  - 23) Location, size and length of all riser nipples
  - 24) Type of fittings, couplings and joints and their location
  - 25) Type and location of all hangers for the mains and branch lines typical hanger location detail is sufficient.
  - 26) Hanger detail (Information to include size of rods and size and type of fasteners). When piping greater than 4" is supported by a lightweight roof structure (i.e. bar joist, composite wood joist, Z-purlins, etc.), structural review/approval by a registered professional engineer is required to verify the roof structure is adequate to support the weight of the water filled piping plus 250 pounds applied at the point of hanging.
  - 27) Location and details of lateral and longitudinal sway bracing, including spacing, zone of influence loads, angle, fastener type and size. When piping greater than 4" is supported by a lightweight roof structure (i.e., bar joist, composite wood joist, Z-purlins, etc), structural review/approval by a registered professional engineer is required to verify the roof structure is capable of carrying the added applied seismic loads.
  - 28) Test connections, main drain and inspectors test valve.
  - 29) Indicate size, location, type of nozzle and length of hand held hose.
  - 30) Indicate location, type and size of fire department connection.
  - 31) Indicate location of exterior control valve.
  - 32) Type and size of underground pipe
  - 33) Type of underground fittings
  - 34) Location of thrust blocks and details
  - 35) Make, model and type of the backflow prevention device
  - 36) Key plan showing the location of tenant work, in relation to the existing building or structures
  - 37) Design criteria for the system.
  - 38) Calculation information, stating the system design pressure and flow at the base of the riser
- n) The following information shall be contained on the hydraulic calculations:
- 1) Sprinkler "K" factor
  - 2) Justification for altered "K" factor
  - 3) Hydraulic reference points
  - 4) Current water flow test information
  - 5) Pipe size, with internal diameters
  - 6) Pipe length

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- 7) All fittings
  - 8) Friction loss per foot
  - 9) Total friction loss between reference points
  - 10) Elevation in psi at each reference point
  - 11) Required pressure at each reference point
  - 12) A standard cover sheet with all necessary information
  - 13) A water supply curve, including a 10% reduction
  - 14) In rack sprinkler demand, if applicable, balanced with the overhead system.
  - 15) Inside and outside hose demands at their respective connection points
2. Preferred: No preferences
  3. Disallowed:
    - a) Tandem systems are not permitted. Definition: A sprinkler system in a detached building which is supplied from the overhead fire sprinkler system piping of another building or has its supply piping running through the other building.
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Fire department connection (FDC)
1. Required:
    - a) One FDC shall serve all automatic sprinkler systems on a subject property.
  2. Preferred: No Preference
  3. Disallowed: None
- B. System control valves
1. Required:
    - a) System control valves shall be of an indicating type valve assembly.
    - b) Each sprinkler riser shall have a readily visible, accessible above grade exterior indicating control valve.
    - c) Each fire protection system shall have a main post indicator valve (PIV) located at the city connection, on the supply side of the FDC.
    - d) Systems with a backflow prevention device may use the system side OS&Y valve to meet the requirements of the PIV (above), provided the valve is clearly visible and accessible at all times from the fire department access road.
    - e) Wall post indicator valves may be used as the systems main control valve were short lengths of underground exist. (A listed indicating control valve may be used only when the riser is on the exterior of the building and readily visible and accessible). Note: The FDC shall be tied in on the system side of this control valve when feeding a single sprinkler system.
    - f) In multi-story/level buildings (including basements) over three levels, the following devices shall be provided at each floor level in a rated shaft or stairway:
      - 1) Indicating control valve
      - 2) Water flow detector with an alarm bell
      - 3) Drain valve

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- 4) Inspectors test valve with sight gauge
  - g) Sectional control valves for underground fire mains shall be post indicator type (PIV). In unique situations when above ground valves cannot be used, a central station service monitored electronically supervised indicating valve in an approved vault may be allowed. Valves shall be provided as follows:
    - 1) Provide a sectional control valve on each side of the supply connection to the loop and one at the opposite side of the loop. This also applies to systems which "Y" or split into two or more separate legs, but do not actually complete a loop.
    - 2) Sectional control valves shall be required for each combination of five sprinkler risers and/or hydrants. Rack sprinkler risers need not be counted when determining these units.
  - h) Underground piping serving both on-site hydrants and sprinkler systems shall be designed whereby on-site hydrants will not be shut off when the sprinkler systems exterior control valve is turned off.
  - i) System control valves and FDCs shall have a permanent sign identifying areas or systems controlled. Signs shall be metal, have raised lettering, painted white with minimum red letters 1" high with 3/16" stroke and shall be permanently banded to the valve or permanently affixed to a wall.
  - j) All control valves shall be locked in the open position, with a non-case-hardened lock.
  - k) All control valves shall be readily accessible and located within 7'-0" above the floor.
  - l) Sprinkler systems located in special hazard areas (i.e., spray booth, trash chutes, etc.) shall have a separate indicating control valve. This valve shall be supervised in the same manner as the building's sprinkler system control valve.
2. Preferred: No preferences.
  3. Disallowed:
    - a) Underground gate valves are not acceptable for sprinkler system control valves.
- C. Alarms
1. Required:
    - a) An exterior alarm bell shall be provided for each riser and shall be located adjacent to that riser in order to clearly identify which riser is flowing water.
    - b) In multi-story buildings, in addition, one bell shall be located on the exterior of the building, adjacent to the main riser.
    - c) Spare sprinklers and a sprinkler wrench shall be located on the premises, near a riser or a sign at the riser to indicate the location of spare sprinklers. Spare sprinklers shall be accessible to the fire department at all times.
    - d) All fire protection equipment that is susceptible to mechanical damage shall be provided with barricades.
  2. Preferred: No preferences
  3. Disallowed: None
- D. Underground piping
1. Required:

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- a) Underground supply pipe may run up to a maximum of 10 feet in length under a building's footprint or structure to supply a riser, which cannot be located directly adjacent to an exterior wall.
  - b) Any pipe located under a building shall be ductile iron or listed as equal.
  - c) Thrust blocks shall be designed based on a safety factor of 1.5, or a minimum water pressure of 150 psi, whichever is greater.
  - d) Copper piping shall be type "K" with brazed joints.
2. Preferred: No preferences.
  3. Disallowed:
    - a) Underground piping shall not run under a building's footprint or structure.
    - b) No pipe joints are allowed in the piping under the building except for the fitting at the rise up.
- E. Hydraulically designed systems
1. Required:
    - a) A 10% reduction in available water pressure shall be provided for all new and upgraded hydraulically calculated sprinkler systems. This will be accomplished by reducing the static and residual pressure by 10% and drawing the new curve. Total system demand and hose stream allowances shall be added together and shall not exceed this new curve.
    - b) Existing sprinkler systems which have been hydraulically calculated shall have new calculations provided any time the system is altered to the point where there is a question as to the location of the hydraulically most remote area.
    - c) Buildings which will have future tenant improvement sprinkler work must have provisions made in the original hydraulic calculations for this future work.
    - d) When an existing building provided with a pipe scheduled system is proposed to be used for "High Piled Stock" or have the addition of in-rack sprinklers, the existing roof sprinklers shall be calculated in accordance with the most current adopted standard for that specific application.
    - e) Hydraulically calculated systems shall be calculated back to the public water supply.
  2. Preferred: No preferences
  3. Disallowed:
    - a) Sprinkler systems which have been hydraulically calculated shall not have pipe schedule additions. These additions shall be calculated.
- F. Smoke vents/skylights
1. Required:
    - a) Custom or recessed skylights may require sprinkler protection
  2. Preferred: No preferences
  3. Disallowed:
    - a) Sprinklers shall not be located in or below smoke vents or standard (4' x 8') skylights.
- G. Tenant spaces
1. Required:
    - a) Head spacing in unoccupied or undeveloped tenant space shall be provided with standard coverage 1/2 " orifice heads in 1" outlets and

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- designed to the appropriate hazard classification of the anticipated tenant. Deflector distances shall be maintained in accordance with NFPA.
- b) Hydraulic calculations shall be provided using an altered “K” for the typical arm-over and flow based on the maximum head spacing anticipated. When the space is developed, the addition of heads shall be restricted to one head per outlet. More than one head may be taken from an existing outlet, when calculations have been provided to justify such.
- 2. Preferred: No preferences
  - 3. Disallowed: None
- H. Special requirements
- 1. Required:
    - a) All underground mains serving private on-site fire hydrants shall be calculated to verify the required on-site fire flow.
    - b) When a fire pump is utilized in a system, a maximum of 125% of its rated capacity may be used in the design of the system.
    - c) When a fire pump is utilized in a system, the water supply shall be adequate to supply the pump at 150% of its rated capacity and shall be tested at 150%.
    - d) When a fire pump is provided, the pump and related equipment shall be located in a separate enclosed room of one-hour fire resistive construction and provided with sprinkler protection.
    - e) Sprinkler heads with the same orifice size shall be utilized within the same area or compartment.
    - f) When pressure-reducing valves (PRV) are used, an approved device for full flow testing shall be provided after the valve and discharged to an approved location. (A minimum 2” main drain valve shall be provided when using 2 ½” PRVs).
    - g) Class 1 standpipes for non-high rise buildings shall be designed as manual wet and calculated such that a maximum 150 psi is required at the FDC to provide the minimum residual pressure required at the most remote valve outlets.
    - h) When a fire pump is provided, provide combined standpipe.
    - i) Sprinkler heads located less than 7’-0” above the floor shall be protected from damage in an approved manner.
    - j) Sprinkler protection shall be provided under all canopies or over hangs greater than 4’-0” wide above hard scape areas.
    - k) All dry type sprinkler systems shall be designed and tested to provide water to the most remote portion of the system within 60 seconds.
    - l) All sprinkler systems designed with a density of .25 gpm or greater shall not exceed 40,000 square feet per riser.
  - 2. Preferred: No preferences
  - 3. Disallowed:
    - a) Automatic sprinkler systems with non-fire protection connections are not allowed.

## 4. INSTALLATION REQUIREMENTS

- A. Required:

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1. Design of overhead and underground fire protection systems shall be performed by individuals/companies meeting the requirements set forth by the State Board of Registration and as follows:
    - a) C-16 (only if also the installing contractor)
    - b) Registered professional engineer (civil, mechanical)
    - c) Registered Fire Protection Engineer
  2. The underground fire sprinkler supply line is the piping between the system shut-off valve, or the fire department connection, up to and including the first pipe connection above grade at the building. Such supply lines and/or any exterior on-site private fire hydrants may be installed by the following licensed contractor:
    - a) General engineering contractor (A)
    - b) Fire Protection contractor (C-16)
    - c) Pipeline contractor (C-34)
    - d) Plumbing contractor (C-36)
  3. All private on-site fire hydrants shall be installed to the following specifications, prior to flow test and acceptance of the system:
    - a) Installed so that the centerline of the lowest outlet is between 14 and 24 inches above finished grade.
    - b) Installed so that the front of the riser is between 12 and 24 inches behind the curb face
    - c) Installed so that the outlets are facing the curb at a 45-degree angle to the curb line
    - d) Of a type and construction which conforms to current American Water Works Association Standard C503
    - e) Provided with a 3-foot unobstructed clearance on all sides.
    - f) Installed so that the fire hydrant is centered on a 3' x 3' x 1' thick concrete pad.
    - g) Provided with approved plastic outlet caps
    - h) All private on-site water mains, laterals, gate valves, buries and risers feeding private fire hydrants shall be a minimum of six inches in diameter.
    - i) When sidewalks are contiguous with a curb and have a width of five feet or less, the front of the fire hydrant riser shall be placed immediately behind the sidewalk. In no case shall a fire hydrant be more than six feet from a curb face.
    - j) Approved fire hydrant barricades shall be installed if curbs are not provided (see V7-C1-S8).
    - k) Piping shall be hydrostatically tested at 200 psi for two hours or at 50 psi above the system operating pressure, whichever is greater
    - l) Adequate (10 feet per second) flushing of the piping, in accordance with NFPA 13.
    - m) Flow test to satisfy fire flow requirements
- B. Preferred:
1. No preferences
- C. Disallowed:
1. Installation shall not begin until plans have been approved by Engineering Services and the fire department. A complete set of approved plans shall be kept at the building site at all times. Contractors installing system without approved plans may be cited.

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### **5. EVALUATION or COMMISSIONING**

- A. Hydrostatic test (minimum 200 psi for two hours, or at 50 psi above the system operating pressure, whichever is greater) shall be conducted on all new systems, upgrades, or partials that involve the installation of over 20 heads. Above ground piping modifications that cannot be isolated shall not require testing in excess of the system working pressure.
- B. Underground piping and fittings shall not be covered or connected to the overhead piping until a hydrostatic test and inspection has been completed. (Center loading is permissible.)
- C. Above ground piping and fittings shall not be concealed until a hydrostatic test and inspection has been completed.
- D. A final inspection by LAFD and LADBS personnel is required on all systems.

**END OF DOCUMENT**



# USC BASIS OF DESIGN

## 21 1314 AUTOMATIC FIRE SPRINKLER SYSTEM

### 1. OVERVIEW

- A. Purpose: USC Preferences And Requirements Are Indicated In This Document.
- B. For Other Related Requirements, Refer To Sections 21 00 00, 10 52 00 and 28 31 00
- C. The Following Table Summarizes The Types Of Particular Requirements Identified Within This Section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X		X	X

- D. This Section Specifies Materials, Methods and Equipment To Be Used For Automatic Sprinkler System, Standpipe System, Fire Pump System And Related Fire Protection Piping To 5 Ft Outside Building.

### 2. PROCEDURAL REQUIREMENTS

- A. Design Considerations Specific To Components In This Section:
  - 1. Required:
    - a) Codes and Standards:
      - 1) NFPA 13, Installation of Sprinkler Systems
      - 2) NFPA 20, Installation of Stationary Pumps for Fire Protection
      - 3) NFPA 30, Flammable and Combustible Liquids Code
      - 4) NFPA 45, Fire Protection for Laboratories Using Chemicals
      - 5) NFPA 72, National Fire Alarm Code
      - 6) Underwriters Laboratories (UL) Fire Protection Equipment Directory
      - 7) California Building Code – Latest Version
      - 8) City of Los Angeles Fire Code – Latest Version
      - 9) California Fire Code – Latest Version
      - 10) Title 19 of California Code of Regulations
      - 11) University of Southern California Design Standards
    - b) Each wet pipe zone shall begin with:
      - 1) Zone control valve with tamper switch.
      - 2) Check Valve (Combined standpipes).
      - 3) Flow switch.
      - 4) Inspectors test and drain valve.
      - 5) Pressure gauge.
    - c) This Section specifies design criteria for fire protection system. Zone and main piping layouts of fire protection system have been established, as it relates to architecture, structure and mechanical/electrical systems. Fire Protection Contractor, based on these layouts, shall produce installation drawings which are also referred to as shop drawings in this Specification.

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- d) Contractor Installation Program:
  - 1) Licensed persons employed by Sprinkler Contractor shall perform planning, calculations, layout and installation. Certified sprinkler designer, National Institute for Certification of Engineering Technologies, (NICET) Level IV or licensed Professional Engineer for planning and calculations and journeyman sprinkler fitters for installation foreman and supervisory personnel.
  - 2) Journeyman automatic fire sprinkler fitter(s) shall supervise field installation.
  - 3) Contractor shall be licensed in the State of California for Installation of Fire Protection Systems.
  - 4) Contractor shall submit pre-qualification evidence of at least 3 projects of comparable size successfully completed with their Bid.
  - 5) Distortion or misrepresentation of qualification evidence may result in Contract cessation.
- e) Electrical Coordination:
  - 1) All relays, wire, conduit, pushbuttons, pilot lights and other devices required for power side or the control of electrical equipment shall be furnished by Division 26 and Division 28 contractors, except as specifically noted elsewhere in this specification.
  - 2) Should any change in electrical equipment size, horsepower rating or means of control be made to any motor or other electrical equipment after contracts are awarded, sprinkler contractor is to immediately notify Division 26 and Division 28 contractors of this change and pay any costs due to this change.
  - 3) Division 26 contractors shall provide all power wiring and sprinkler contractor shall provide all control wiring and its conduit. Control wiring shall conform to Division 26 and 28 requirements for control wiring.
  - 4) Sprinkler contractor shall provide exterior waterflow alarm and coordinate installation with Division 26 and Division 28 contractors.
  - 5) Furnish wiring diagrams to Division 26 and Division 28 contractors for all equipment and devices furnished by the sprinkler contractor which have been indicated to be wired by the Division 26 and Division 28 contractors.
- f) Investigate site conditions; verify utility locations and elevations before start of excavation. Discrepancies will be forwarded to Architect/Engineer before proceeding with construction
- g) Flow test data shall be used as basis for Contract Documents. Sprinkler Contractor, prior to preparation of installation design calculations, shall validate the following flow test data:
  - 1) Static Pressure: XXX psig.
  - 2) Residual Pressure: XXX psig with XXX gallons flowing per minute.
  - 3) Flowing hydrant is located at XXX and pressure-test hydrant is located at XXX.
  - 4) Test Date: XXX
  - 5) Test Time: XXX
  - 6) Elevation of pressure-test hydrant: XXX.
  - 7) Test conducted by or information supplied by: XXX
- h) Send current hydrant flow test data to Engineer.
- i) Fire pump shall be designed to meet Fire Protection System demand.

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- j) Hydraulically calculated system shall be designed to a minimum of 10% below available water flow curve.
- k) Systems that are hydraulically calculated must include 1.2 factor for design area.
- l) Basis of Design:
  - 1) Office areas and general building spaces shall be hydraulically designed to provide minimum density of 0.10 gpm per sq ft over most hydraulically remote 1500 sq ft. Maximum spacing shall not exceed 225 sq ft per head.
  - 2) Laboratory areas including corridors between labs separated from office areas by doors and firewalls shall be hydraulically designed to provide minimum density of 0.15 gpm per sq ft over most hydraulically remote 2000 sq ft. Maximum spacing shall not exceed 130 sq ft per head.
  - 3) Penthouse and other mechanical equipment areas shall be hydraulically designed to provide minimum density of 0.15 gpm per sq ft for most remote 2000 sq ft. Maximum spacing shall not exceed 130 sq ft per head.
  - 4) General storage areas and chemical transfer area shall be hydraulically designed to provide minimum density of 0.20 gpm per sq ft over most hydraulically remote 2000 sq ft. Maximum spacing shall not exceed 100 sq ft per head.
- m) Hose Streams:
  - 1) Add 250 gpm hose stream to sprinkler zone hydraulic calculations.
- n) Fire Protection System Layout and Shop Drawings:
  - 1) Contractor shall review Design Drawings and Specifications and shall produce Shop Drawings, calculations and product data sheets.
  - 2) Conceal sprinkler piping above ceilings where possible.
  - 3) Contractor shall consult with Architect during development of piping layout to avoid conflicts with general appearance. Pipe routing is a critical issue due to attributes of this building.
  - 4) Submit shop drawings, calculations and product data sheets for coordination review to: architect, USC Engineering Services, City of LA and other Authorities Having Jurisdiction over this Project prior to installation (see submittals).
  - 5) Contractor shall be held to have examined "Reflected Ceiling" drawings as well as Mechanical, Electrical, Piping, Information Technology, Structural and Architectural building plans prior to system layout.
  - 6) Contractor shall coordinate routing of piping with other trades and Architect.
  - 7) Contractor shall participate in coordination process and shall not install piping prior to coordination with other trades.
- o) Provide Shop Drawings and Submittals on Items Specified:
  - 1) Pipe and Fittings.
  - 2) Valves.
  - 3) Tamper Switches.
  - 4) Flow Switches.
  - 5) Exterior Weatherproof Waterflow Alarm.
  - 6) Sprinkler Heads.
  - 7) Sprinkler Head Cabinet.

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- 8) Pre-Action Valve and Accessories.
  - 9) Deluge Valve and Accessories.
  - 10) Dry Pipe Valve and Accessories.
  - 11) Hanger Assemblies.
  - 12) Pressure Gauges.
  - 13) Fire Department Connection (FDC).
  - 14) Double Check Backflow Prevention assembly (DCBP).
  - 15) Reduced Pressure Zone Backflow Prevention Assembly.
  - 16) Hydraulic Calculations.
  - 17) Drawings.
  - 18) Seismic Restraint Detailing.
  - 19) Fire Department Valve Cabinets (FVC).
  - 20) Fire Department Valves (FDV).
  - 21) Fire Pump Test Connection.
  - 22) Fire Pump and Accessories.
  - 23) Fire Pump Controller without automatic transfer switch.
  - 24) Jockey Pump and Accessories.
  - 25) Jockey Pump Controller.
- p) Submit fire pump certified shop test curves showing head capacity and brake horsepower to Engineer.
  - q) Include items listed in product section and additional items required to provide complete installation.
  - r) Indicate by red marking or arrow, items to be used where more than 1 item appears on manufacturer's catalog sheet.
  - s) Submit shop drawings, equipment submittals and hydraulic calculations to Engineer and Owner's Insurance representative prior to installation or fabrication of system components.
  - t) Submit shop drawings, product data sheets and hydraulic calculations to Local Fire Department prior to installation or fabrication of system components.
  - u) Include copy of Fire Department plan review letter in submission to Engineer.
  - v) Review of submittals does not relieve Contractor from coordinating installation of work with other trades, or from compliance with Codes and Standards.
2. Preferred: No preferences
  3. Disallowed: None

B. Quality Assurance Requirements Beyond Standard 1 Year Warranty: None Required.

### 3. PRODUCT REQUIREMENTS

#### A. Materials and Equipment

1. Required:
  - a) Materials and equipment in system shall be new and current products of manufacturer regularly engaged in production of such materials and equipment.
  - b) Where 2 or more pieces of equipment are required to perform interrelated functions, they shall be products of 1 manufacturer.
  - c) Clean and cap pipe after fabrication and prior to placing pipe in building.

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- d) Mark pipe with tags that can be removed during installation so no permanent markings remain on unpainted pipe located in exposed areas.
  - e) Couplings shall be tees with capped outlets.
  - f) Unless otherwise shown, products shall be UL Listed in the latest publication of the UL Fire Protection Equipment Directory or Approved in the latest Factory Mutual Approval Guide for service intended.
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- B. Above Ground Pipe
- 1. Required:
    - a) Carbon steel pipe, Schedule 10, ASTM A795, ASTM A53 or A135, roll-grooved for mechanical fittings.
    - b) Carbon steel pipe, Schedule 40, ASTM A795, ASTM A53 or A135, cut-grooved for mechanical fittings.
    - c) In areas such as tight ceiling spaces or where exact center-of-tile placement is critical, only FlexHead sprinkler pipe is permitted. Models 2024, 2036, 2048, 2060, 2072 as manufactured by FlexHead Industries, Acton Massachusetts. Each FlexHead ceiling sprinkler system shall include multi-port ceiling mounting bracket and a 1-piece tested FlexHead sprinkler drop including adjustable flange and hardware. No other flexible sprinkler pipe is allowed for this project unless it is both UL Listed and Factory Mutual Approved. Alternates to FlexHead flexible sprinkler pipe must also be acceptable to Owner.
    - d) Provide metal pipe's exposed threads with corrosion inhibitive paint.
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- C. Above Ground Fittings
- 1. Required:
    - a) Cast iron threaded, Class 125, 175 psi WOG pressure rating, ANSI B16.4.
    - b) Cast iron flanged, Class 125, 175 psi WOG pressure rating, ANSI B16.1.
    - c) Grooved:
      - 1) Ductile iron or malleable iron, grooved for mechanical coupling, 175 psi WOG pressure rating, malleable iron conforming to ASTM A536 for ductile iron and ASTM A47 for malleable iron.
      - 2) Fitting, gasket and coupling shall be furnished by same manufacturer.
      - 3) Acceptable manufacturers: Gruvlok, Victaulic, Viking Corp. or equal.
    - d) Fitting, gasket and coupling shall be furnished by same manufacturer.
    - e) Wrought copper fittings, pressure rated, solder type, ANSI B16.22.
    - f) Galvanized, cast iron, threaded fittings, 175 psi WOG pressure rating, ANSI B16.4.
    - g) Fittings shall be galvanized when installed on galvanized piping.
    - h) Weld-o-lets welded to piping in fabrication shops are permitted.
  - 2. Preferred: No preferences
  - 3. Disallowed:
    - a) Pipe-o-lets or similar clamp on or saddle type fittings are not allowed as fittings.
    - b) No welding allowed at project site.
    - c) Saddle type devices that strap or clamp onto piping are not allowed.

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### D. Above Ground Joints

1. Required:
  - a) Threaded joints:
    - 1) Tapered pipe threads, ANSI B1.20.1.
  - b) Flanged:
    - 1) Cast iron, 175 psi WOG pressure rating, ANSI B16.1.
    - 2) Square head machine bolts with semi-finished hexagon nuts, ASTM A183.
    - 3) Neoprene gasket.
  - c) Mechanical coupling:
    - 1) Grooved couplings shall be of same manufacturer as used for grooved fittings.
    - 2) Malleable iron, ASTM A47, equal to Victaulic No. 75.
    - 3) Rigid mechanical, ASTM A536, equal to Victaulic No. 005.
    - 4) Gaskets: Grade E EPDM gasket per UL 157 and UL 213.
    - 5) Rigid or zero flex type couplings shall be used when operating pressures may cause piping to move out of place or sway on hangers. Flexible couplings may be used where piping is securely braced or clamped into rigid position.
    - 6) Plain end couplings (Roust-A-Bouts, Plainloks or similar couplings) are not allowed on either new or existing sprinkler systems.
  - d) Shop welded joints.
    - 1) Welding electrodes shall be Lincoln or equal with coating and diameter as recommended by manufacturer for type and thickness of work being done.
2. Preferred: No preferences
3. Disallowed: None

### E. Valves

1. General
  - a) Required:
    - 1) Provide identification sign (enamel on metal) for valves per NFPA requirements. For additional information, refer to Section 20 05 53 - Mechanical Systems Identification.
    - 2) Valves in galvanized piping shall be bronze.
  - b) Preferred: No preferences
  - c) Disallowed: None
2. Gate Valve:
  - a) Required:
    - 1) Acceptable manufacturers: Kennedy, Milwaukee Valve Co., Mueller, Nibco, Stockham, Victaulic.
    - 2) Outside screw and yoke (OS&Y), gate valve, bronze body and trim or cast iron body bronze mounted and rated for 175 psi, non-shock cold water working pressure, Nibco F-607-OTS or equal.
  - b) Preferred: No preferences
  - c) Disallowed: None
3. Check Valve:
  - a) Required:
    - 1) Acceptable manufactures: Tyco Fire Products, Reliable, Viking Corp.

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- 2) Iron body, bronze seat, stainless steel clapper with a replaceable rubber seal and 175 psi nonshock cold water working pressure. Viking Model G-1 or equal.
  - b) Preferred: No preferences
  - c) Disallowed: None
4. Ball Valve:
  - a) Required:
    - 1) Acceptable manufacturers: Nibco, Milwaukee Valve Co., Mueller, Stockham, Victaulic.
  - b) Preferred: No preferences
  - c) Disallowed: None
5. Butterfly Valve:
  - a) Required:
    - 1) Acceptable manufacturers: Kennedy, Nibco, Milwaukee Valve Co., Mueller, Stockham, Victaulic.
    - 2) Milwaukee Valve Co., Series BB or equal.
    - 3) Kennedy Valve Co., Fig. 0IG, Victaulic Series 705 Firelock or equal for valve sizes 2-1/2" to 8".
  - b) Preferred: No preferences
  - c) Disallowed: None
6. Double Check Backflow Prevention Assembly (DCBP):
  - a) Required:
    - 1) Acceptable manufacturers: Conbraco, Cla-Val, Febco, Watts.
    - 2) Weighted clapper double check valve assembly including 2 OS&Y gate valves.
    - 3) Assembly shall be double check valve assembly for cross connection devices.
    - 4) Certified in accordance with ASSE 1015 and AWWA C510-97.
    - 5) Double check valve shall be selected based on minimal pressure drop to allow maximum available pressure to sprinkler system.
  - b) Preferred: No preferences
  - c) Disallowed: None
7. Reduced Pressure Zone Backflow Prevention Assembly (RPZ):
  - a) Required:
    - 1) Acceptable manufacturers: Conbraco, Cla-Val, Febco, Watts.
    - 2) Assembly shall consist of 2 independently operating, spring loaded cam-check valves and include 2 OS&Y gate valves.
    - 3) Assembly shall have a hydraulically operated differential pressure relief valve located between and below cam-checks.
    - 4) Certified in accordance with ASSE 1013 and AWWA C511-97.
    - 5) Assembly shall be selected based on minimal pressure drop to allow maximum available pressure to sprinkler system.
  - b) Preferred: No preferences
  - c) Disallowed: None
8. Test and Drain Valves:
  - a) Required:
    - 1) Acceptable manufacturers: AGF, Victaulic or equal.
    - 2) AGF TESTanDRAIN Victaulic Style 720 TestMaster II or equal may be installed.
  - b) Preferred: No preferences
  - c) Disallowed: None

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9. Drain Valves:
  - a) Required:
    - 1) Acceptable manufacturers: Kennedy, Nibco or equal.
    - 2) Thread-in bonnet bronze globe valves, rated to 175 psi non-shock cold water working pressure.
    - 3) Low point drain valves shall have, 3/4" brass nipple with 3/4" male hose threads and cap.
  - b) Preferred: No preferences
  - c) Disallowed: None
10. Pressure Regulating Valves:
  - a) Required:
    - 1) Acceptable manufacturers: Croker, Elkhart, Potter-Roemer.
    - 2) Valve shall be able to regulate inlet pressure up to 400 psi, brass body with brass and stainless steel internal parts, field adjustable indicating scale, non-rising stem, red handwheel, tamperproof monitor switch adapter. Potter-Roemer Model 4036-MSA1 or equal for in-line applications and Model 4035-MSA1 or equal for end-of-line applications.
  - b) Preferred: No preferences
  - c) Disallowed: None
11. Fire Department Valve (FDV):
  - a) Required:
    - 1) Acceptable manufacturers: Croker, Elkhart, Potter-Roemer.
    - 2) Fire Department valve shall be 2-1/2" angle valve, cast brass body, [polished brass] [rough brass] [polished chrome plated] finish, equal to Potter-Roemer Model 4065. Valve cap for 2- 1/2" valve shall be [2-1/2" x 1-1/2" hose adapter reducer Potter-Roemer Model 2810 with 1-1/2" cap with chain, Potter-Roemer Model 4615 or equal] [2-1/2" cap with chain, Potter-Roemer Model 4625 or equal]. Cap and chain finish shall match finish of valve body. Threads shall match Fire Department Standards.
  - b) Preferred: No preferences
  - c) Disallowed: None

### F. Tamper Switch

1. Required:
  - a) Acceptable manufacturers: Potter, System Sensor or equal.
  - b) Outside screw and yoke (OS&Y) supervisory switch, NEMA 4 enclosure, provided with 2 sets of contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Equal to Potter OSYSU-2. Provide [with] [without] optional cover tamper kit. For areas identified as hazardous locations, provide "EX" Model.
  - c) Control valve supervisory switch, NEMA 4 enclosure, provided with 2 sets of contacts rated at 2.5 Amps at 30 VDC and 15 Amps at 125/250 VAC. Equal to Potter PCVS-2. Provide [with] [without] optional cover tamper kit. For areas identified as hazardous locations, provide "EX" Model.
  - d) Tamper switch shall be capable of transmitting signal during first 2 revolutions of handwheel or during 1/5 of travel distance of valve control apparatus from its normal position.
  - e) Unit shall be compatible with Fire Alarm System.
2. Preferred: No preferences



## USC BASIS OF DESIGN

3. Disallowed: None
- G. Flow Switch
1. Required:
    - a) Acceptable manufacturers: Potter, System Sensor, or equal.
    - b) Vane type waterflow switch for use in wet sprinkler systems, 450 psi service pressure rating, 10 gpm minimal flow rate to activate alarm, 2 sets of SPDT (Form C) contacts rated at 2 Amps at 30 VDC and 15 Amps at 125/250 VAC. Provide [with] [without] optional cover tamper kit. Equal to Potter VSR-F.
    - c) Unit shall be compatible with Fire Alarm System. Potter model VSR-F or equal.
  2. Preferred: No preferences
  3. Disallowed: None
- H. Sprinkler Head
1. Required:
    - a) Shall be manufactured by Reliable Automatic Sprinkler Corporation, Tyco Fire Products or Viking Corp.
    - b) Automatic, having temperature rating suitable for location.
    - c) Light Hazard occupancies shall be Quick Response type sprinkler heads.
    - d) Architect will review deviations from the specified styles for approval prior to installation.
    - e) Provide the following type of sprinkler head:
    - f) Unfinished areas such as mechanical spaces, central utility plant, tunnels:
      - 1) Brass Upright or Pendent, 1/2" orifice, ordinary temperature class (155°F), Viking Model M, Micromatic or equal.
      - 2) Extended coverage, brass finish, Upright or Pendent, large orifice, ordinary temperature class (155°F), Viking ECOH-ELO or equal designed and installed per its listing.
    - g) In areas with ceilings.
      - 1) Concealed Pendent, 1/2" orifice, ordinary temperature class (165°F) solder link, Viking Horizon Mirage, Model B-2 adjustable sprinkler, with 135°F temperature rated cover plate, flush with ceiling or equal. Cover plate color shall match ceiling color and shall be factory-painted (i.e. by manufacturer).
    - h) In areas where ceiling conditions do not permit installation of pendent head or finished area where sidewall head provides better coverage of hazard.
      - 1) Polished Chrome Sidewall, 1/2" orifice, ordinary temperature class (155°F), 2-piece adjustable chrome escutcheon, Viking Model M, HSW horizontal or VSW vertical sidewall with Viking E-1 escutcheon or equal.
      - 2) Extended Coverage Sidewall, ordinary temperature class (155°F), Tyco Fire Products, Model TY-FRB or equal designed and installed per its listing.
    - i) In walk-in coolers and freezers.
      - 1) Polished chrome dry pendent 1/2" orifice, ordinary temperature rating, adjustable recessed chrome escutcheon, Viking Model M or equal. Provide compatible wire cage sprinkler head guard where sprinklers are subject to impact damage.

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- j) In unfinished areas where conditions do not permit installation of upright or pendent head:
    - 1) Brass Sidewall, 1/2" orifice, ordinary temperature class (155°F), Viking Model M, HSW horizontal or VSW vertical sidewall or equal.
  - k) Type XXX: In areas requiring window sprinkler protection:
    - 1) 1/2" orifice, [155°F] [200°F,] [horizontal sidewall] [pendent vertical sidewall] Tyco Fire Products, Model WS, Quick Response or equal.
  - l) Submit samples for examination and approval when appearance is different than sprinkler head specified.
  - m) Temperature ratings of sprinkler heads shall vary if installed close to heat sources, under skylights or in special hazard areas.
  - n) Sprinkler Cabinets:
    - 1) Complete with required number of spare sprinkler heads of each type and temperature rating and special wrenches per NFPA 13
    - 2) Provide multiple cabinets to meet this requirement.
    - 3) Coordinate cabinet locations with Owner's representative.
- 2. Preferred: No preferences
  - 3. Disallowed: None
- I. Fire Department Valve Cabinets
- 1. FIRE DEPARTMENT VALVE CABINETS (FVC-1)
    - a) Required:
      - 1) Cabinet: recessed, Potter-Roemer Series 1810 or equal.
      - 2) Door Style: [Full Glass] [Break Glass] [Solid Metal], white polyester coating with identifying decal.
      - 3) Angle Valve: Female x Male, 2-1/2" cast brass, [polished brass] [rough chrome plated] [polished chrome plated] finish with threads to match local Fire Department Standards. Potter-Roemer 4065 or equal.
    - b) Preferred: No preferences
    - c) Disallowed: None
  - 2. FIRE DEPARTMENT VALVE CABINETS (FVC-2)
    - a) Required:
      - 1) Cabinet: surface mounted, Potter-Roemer Series 1815 or equal.
      - 2) Door Style: [Full Glass] [Break Glass] [Solid Metal], white polyester coating with identifying decal.
      - 3) Angle Valve: Female x Male, 2-1/2" cast brass, [polished brass] [rough chrome plated] [polished chrome plated] finish with threads to match local fire department standards, Potter-Roemer 4065 or equal.
    - b) Preferred: No preferences
    - c) Disallowed: None
- J. Fire Department Connection (Fdc)
- 1. Required:
    - a) Acceptable Manufacturers: Badger-Powhatan, Elkhart Brass, Croker Corp., Potter-Roemer, Tyco Fire Products, or equal.
    - b) Flush type, cast brass body with drop clappers, [polished brass] [rough chrome plated] [polished chrome plated] finish, with lettering reading AUTOSPKR STANDPIPE.

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- c) Unit shall include four 2-1/2" chrome plated brass snoots with rigid end threading to match local fire department standards by pin-lug hose thread swivels, pin-lug plugs and chains, Elkhart 166 or equal.
- 2. Preferred: No preferences
  - a) Disallowed: None
- K. Ball Drip
  - 1. Required:
    - a) Acceptable manufacturer: Potter-Roemer, Reliable, Tyco Fire Products or equal.
    - b) Provide bronze ball drip for Fire Department connection inside of building and pipe to nearest floor drain, or discharge to exterior.
    - c) Exterior discharge must be coordinated with Architect and Owner.
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- L. Fire Pump (Fp-1)
  - 1. Required:
    - a) Acceptable Manufacturers: Aurora Pump, A-C Fire Pump, Fairbanks Morse Pump, Patterson Pump and Peerless Pump.
    - b) Fire pump shall meet following criteria:
      - 1) Deliver rated flow at rated pressure.
      - 2) Deliver not less than 65% of rated pressure at 150% rated capacity.
      - 3) Not exceed 140% of rated pressure at shutoff.
    - c) Pump Type: Electric Driven.
    - d) Pump Configuration: Horizontal.
    - e) Rated Flow: 750 gpm.
    - f) Pump shall be sized to provide 100 PSI at the top of the hydraulically most remote standpipe.
    - g) Pump and motor shall be mounted on common steel baseplate.
    - h) Motor:
      - 1) Provide open drip proof, high-efficiency, foot-mounted.
      - 2) [200] [230] [460] VAC, 3 phase, 60Hz and XXX rpm.
      - 3) Shall not exceed 60 HP.
      - 4) Locked rotor current shall not exceed values specified in NFPA 20.
    - i) Accessories to be provided with each fire pump are as follows:
      - 1) Fire Pump Test Connection:
        - i) Test connection shall be flush type, cast brass body, polished [chrome] [brass] plated with lettering reading "PUMP TEST CONNECTION".
        - ii) Unit shall include XXX 2-1/2", polished [chrome] [brass] plated caps with chains.
        - iii) Potter-Roemer XXX or equal.
      - 2) Eccentric Suction Reducer.
      - 3) Concentric Discharge Increaser.
      - 4) Base Elbow.
      - 5) Reducing Tee.
      - 6) Complete Discharge Tee.
      - 7) Closed Discharge Cone.
      - 8) Suction and Discharge Gauges.
      - 9) 3/4" Circulation Relief Valve.

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- 10) Automatic Air Release Valve.
  - 11) Ball Drip Valve.
  - 12) Splash Partition.
  - 13) Discharge Check Valve.
2. Preferred: No preferences
  3. Disallowed: None
- M. Control Equipment For Electric Drive
1. Required:
    - a) Acceptable Manufacturers: Eaton/Cutler-Hammer, Firetrol, Inc., Joslyn Clark, Metron Inc.
    - b) Fire Pump Controller:
      - 1) Shall be completely assembled, wired and tested by control manufacturer before shipment from factory.
      - 2) Shall be labeled "Fire Pump Controller".
      - 3) Shall be located as close as practical and within sight of motor.
      - 4) Shall be located and protected such that it will not be damaged by water escaping from pump or connections.
      - 5) Shall be combined manual and automatic.
      - 6) Heavy gauge formed steel, NEMA Type 12 enclosure with top drip hood.
      - 7) Provide complete with following:
        - i) Starter: [Reduced Voltage wye-delta closed] [Reduced Voltage wye-delta open][Reduced Voltage Solid State] [Reduced Voltage Auto Transformer] [Reduced Voltage Part Winding] [Reduced Voltage Primary Resistor] [Full Voltage Across-the-Line].
        - ii) Isolating Switch: Externally operable, quick-break type.
        - iii) Circuit breaker: Refer to Electrical Specifications and Electrical Drawings for interrupting capacity.
        - iv) Locked rotor protector for drive motor.
        - v) Pilot light to show circuit breaker closed and power available.
        - vi) Ammeter and voltmeter displays on front of panel.
        - vii) Alarm relay to energize audible or visible alarm.
        - viii) Pressure recording device.
        - ix) Voltage surge protection.
        - x) Contacts for remote alarm of:
          - Pump Running.
          - Loss of Line Power in any phase.
          - Phase Reversal.
          - Controller Connected to Alternate Source.
        - xi) Provide remote fire pump alarm panel in a location of constant attendance:
          - Pump alarm panel shall be key lockable, NEMA, Type 1 enclosure consisting of audible or visible alarms.
          - Alarms shall show: "Pump Running"; "Supervisory Power Failure"; "Phase Reversal" and when required by NFPA 20, "Controller Connected to Alternate Source".
  2. Preferred: No preferences
  3. Disallowed: None

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- N. Jockey Pump (Jp-1)
1. Required:
    - a) Acceptable manufacturers: Aurora Pump, A-C Fire Pump, Fairbanks Morse Pump, Patterson Pump, Peerless Pump.
    - b) Jockey pump shall be:
      - 1) Same manufacturer as main fire pump.
      - 2) Centrifugal jockey pump rated for XXX gpm at XXX psig.
    - c) Motor shall be:
      - 1) XXX HP.
      - 2) XXX rpm.
      - 3) [200] [230] [460] VAC.
      - 4) 3-phase, Jockey pump shall be close-coupled.
      - 5) Open Drip Proof (ODP).
      - 6) Pump and motor shall be integrally mounted on common steel baseplate.
  2. Preferred: No preferences
  3. Disallowed: None
- O. Jockey Pump Controller
1. Required:
    - a) Acceptable manufacturers: Joslyn Clark, Firetrol, Inc., Metron Inc., Eaton/Cutler-Hammer.
    - b) Jockey pump controller shall be same manufacturer as main fire pump controller.
    - c) Jockey pump controller:
      - 1) Wall mounted, NEMA Type 1 control cabinet.
      - 2) Maintain automatic sprinkler system at 5-10 psi above fire pump starting pressure.
      - 3) Mercury-free pressure switch with independent adjustment.
      - 4) Multiple position control switch.
      - 5) 3-pole disconnect switch.
      - 6) Starter.
  2. Preferred: No preferences
  3. Disallowed: None
- P. Hangers
1. Required:
    - a) Provide hangers to support piping: in perfect alignment without sagging or interference, to permit free expansion and contraction and meet requirements of NFPA 13.
    - b) Concrete expansion anchors are to be Hilti, Rawl, or Phillips concrete fasteners.
  2. Preferred: No preferences
  3. Disallowed:
    - a) Riser clamps shall not protrude more than 2" beyond edge of hole. Provide Anvil Fig. 261 or equal.
- Q. Earthquake Bracing
1. Required:

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- a) Sprinkler and standpipe system shall be protected from earthquake influence in accordance with requirements of NFPA 13 and as outlined in Section 20 05 49 - Seismic Anchorage and Restraints.
  - b) Provide flexible couplings, bracing and other components required, compatible with piping material and jointing system used.
  - c) Seismic detailing shall be included on Fire Protection System layout shop drawings.
2. Preferred: No preferences
  3. Disallowed: None
- R. Pressure Gauges
1. Required:
    - a) Acceptable manufacturers: Potter-Roemer, Viking or equal.
    - b) Pressure gauges shall be 3-1/2", corrosion resistant moving parts, polycarbonate window and provided with connection not smaller than 1/4" NPT.
    - c) Include shutoff valve with provisions for draining on each pressure gauge.
  2. Preferred: No preferences
  3. Disallowed: None
- S. Dielectric Fittings
1. Required:
    - a) Acceptable manufacturers: Epco Sales, Inc., Lochinvar, Watts Regulator Co., Wilkins or equal.
    - b) Insulating nipple, metal casing, inert thermoplastic lining, Clearflow dielectric fitting by Perfection Corporation.
    - c) Dielectric unions 2" and smaller; dielectric flanges 2" and larger; with iron female pipe thread to copper solder joint or brass female pipe thread end connections, non-asbestos gaskets and pressure rating of not less than 175 psig at 180°F.
  2. Preferred: No preferences
  3. Disallowed: None

## 4. INSTALLATION REQUIREMENTS

- A. General
1. Required:
    - a) Install hydraulically designed sprinkler system and associated accessories according to requirements of NFPA 13 and as shown on drawings.
    - b) Install hydraulically designed standpipe system and associated accessories according to requirements of NFPA 14 and as shown on drawings.
    - c) Install pipe and fittings according to recommendations of pipe manufacturer.
    - d) Keep materials within listed temperature range to assure jointing in accordance with manufacturer's requirements.
    - e) Pipe and fittings shall be of corresponding materials when assembled.
    - f) For underground pipe, in lieu of thrust blocks; anchors and tie rods can be provided. Tie rods shall be 3/4" diameter steel rod. Clamps shall be 3/8" thick by 2" wide steel. Each clamp shall be secured with four 5/8" diameter bolts.

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- g) Apply asphaltum or corrosion inhibitive paint to tie rods, clamps and bolts of underground pipe.
- h) Provide readily removable fittings at end of cross-mains. Minimum size of flushing connection shall be 2".
- i) Provide test connection for each flow switch.
- j) Discharge test connections inside building to receptacles provided as part of plumbing system or to drain standpipe.
- k) Drain line detailed adjacent to standpipe/sprinkler risers shall be considered as part of Sprinkler System from combination test/auxiliary drain valve for each zone or sub-zone shown on plans to plumbing receptacle.
- l) Provide auxiliary drains at low points of systems. Where trapped section of pipe exceeds 5 gallons, drain shall consist of, as a minimum: valve, 3/4" brass nipple with 3/4" male hose threads and cap.
- m) Identify valve with brass tag denoting which flow switch is being tested, when test valves are located remote from flow switch.
- n) Clamp-on or saddle type fittings are not allowed. Outlet fittings inserted into holes drilled into piping or pipe-o-lets are not allowed.
- o) O. Provide reducing fittings or provide shop fabricated weld-o-lets to change pipe sizes in sprinkler/standpipe systems. No bushings or grooved reducing couplings, such as Victaulic Style 750, are allowed.
- p) Feed sprinkler heads, installed in finished ceilings, with swing joint or return bend arrangement for final positioning in ceiling grid pattern during construction phases. Sprinklers are required to be installed in the center of ceiling tiles.
- q) Provide minimum 1" outlets with sprigs or drops for sprinklers located in shelled spaces.
- r) Install tamper switch on each shutoff valve.
- s) Install locking device with each shutoff valve to prevent inadvertent closing of valve. Keys shall be indexed to identify valve location.
- t) Install sprinkler heads as recommended by manufacturer. Sprinklers shall be set level and at locations to avoid interference with spray pattern of sprinkler. When ducts and lights are obstructions to sprinkler distribution, provide additional heads beneath obstruction.
- u) Make joints of threaded pipe by cutting pipe square and reaming inside.
- v) Coat exposed threads with corrosion inhibitive paint. Use joint compound sparingly.
- w) Install joints for mechanical coupled pipe according to manufacturer's recommendations. Use manufacturer's gasket lubricant sparingly.
- x) Pipe shall be cut grooved for Schedule 40 steel pipe or roll grooved for Schedule 10 steel pipe as specified by coupling manufacturer.
- y) Welded joints shall be made in fabrication shop. No welding allowed at project site.
- z) Hang pipe from building members using concrete inserts or beam clamps. Expansion type inserts may be used for branch piping.
- aa) Support piping in accordance with NFPA 13 and Section 15025 - Seismic Anchorage and Restraints and in accordance with State and Local seismic restraint requirements.
- bb) Include seismic restraint details with sprinkler shop drawings.
- cc) Install pressure gauges as required in manufacturer's installation instructions and as required per NFPA.

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- dd) Generally install capped tees in lieu of couplings for future connections.
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- B. Fire Pump Installation
- 1. Required:
    - a) Install fire pump, jockey pump and their controllers per manufacturer's installation instructions, as shown on drawings and as required in NFPA 20.
    - b) Grout base mounted pumps after securely anchoring to structure.
    - c) Provide flexible connections as shown and required.
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- C. Bonding
- 1. Required:
    - a) Provide underground cast iron and underground ductile iron pipe with metallic bond at each joint.
    - b) Bond wire shall be type RHW-USE size 1/0 neoprene-jacketed copper conductor shaped to stand clear of joint.
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- D. Cleaning
- 1. Required:
    - a) Ensure underground feed pipe has been flushed, to clear out construction debris, prior to connecting aboveground fire protection system to it.
  - 2. Preferred: No preferences
  - 3. Disallowed: None.

## 5. EVALUATION or COMMISSIONING

- A. General
- 1. Refer to testing paragraph of Section 20 0000 - General Mechanical Requirements.
  - 2. Perform all NFPA required acceptance tests.
  - 3. Test sprinkler system as entire system or partial system. System shall be hydrostatically tested at not less than 200 psi or 50 psi above static pressure in excess of 150 psi for 2 hrs. No leakage allowed. Replace defective joints with new materials. No caulking of defective joints allowed. Re-test system after defective joints are replaced, until satisfactory results are obtained.
  - 4. Hydrostatically test piping between the exterior fire department connection (FDC) and the check valve in the fire department inlet pipe in the same manner as the balance of the system.
  - 5. Pipe shall not be concealed until satisfactorily pressure tested.
  - 6. Conduct drain test. Record static pressure and residual pressure per NFPA 13.
  - 7. Owner's representative or engineer may witness tests. Contractor shall notify Owner and Engineer a minimum of 3 days in advance to allow for participation.
  - 8. Log of tests shall be kept at job site and shall identify:
    - a) Who performed test.
    - b) Time of test.



## USC BASIS OF DESIGN

- c) Date of test.
  - d) Section of system tested.
  - e) Results of test.
  - f) Along with completed Contractor's Material and Test Certification form(s) from NFPA 13 and NFPA 14.
- 9. Operate flow switches to test that signals are transmitted to Fire Alarm Control Panel.
  - 10. Include test for tamper switches.
  - 11. At completion of acceptance tests:
    - a) Send copy of test log to Engineer.
    - b) Send copy of Contractor's Material and Test Certificates and fire pump test results to:
      - 1) Engineer
      - 2) Owner
      - 3) Authority Having Jurisdiction
    - c) Provide Owner with following:
      - 1) Manufacturer's literature and instructions describing operation and maintenance of equipment and devices installed.
      - 2) Current copy of NFPA 25, Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems.
- B. Fire Pump Testing
- 1. Test fire pump, jockey pump and their controllers per manufacturer's installation instructions and as required in NFPA 20.
  - 2. Furnish test certificate indicating suction pipe has been flushed and suction and discharge pipe has been hydrostatically tested in accordance with NFPA 20, prior to fire pump acceptance test.
  - 3. Coordinate fire pump acceptance test so Local Authorities, Owner's representatives and Insurance Company representatives can witness the test.
  - 4. Owner's representative or Engineer may witness tests. Contractor shall notify Owner and Engineer a minimum of 3 days in advance to allow for participation.
  - 5. Representatives from following shall be present for fire pump field acceptance test:
    - a) Pump manufacturer.
    - b) Controller manufacturer.
    - c) Transfer switch manufacturer.
  - 6. Coordinate fire pump test with local utilities to verify acceptable method for disposal of water.
  - 7. Provide equipment to perform fire pump test, including:
    - a) Calibrated test gauges.
    - b) Calibrated tachometer.
    - c) Hoses.
    - d) Nozzles.
    - e) Valves

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 22 0000 PLUMBING DESIGN REQUIREMENTS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to all product based sections.
- C. The following table summarizes the types of particular requirements identified within this section:

<b>Requirements listed</b>	<b>Preferences Listed</b>	<b>Disallowed items listed</b>	<b>Item requiring commissioning/testing</b>
<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>

- D. Additional Information:
  - 1. Client Goals are stated as follows:
    - a) Ease of Installation.
    - b) Ease of operation and maintenance.
    - c) Energy efficient.
    - d) Proven reliability.
    - e) Well established design principles.
    - f) Constructed of standard, use-proven materials.
    - g) Acceptable procurement lead time.
    - h) Low initial cost.
    - i) Low Operating cost.
    - j) Low Maintenance cost.
    - k) Low life cycle cost for energy efficient installations that incur a higher initial cost.
    - l) Environmentally friendly.
    - m) Acoustically compatible with occupied spaces as described in Section 13 48 00.
    - n) Resistance to vandalism.
    - o) Minimum disruption of occupants during renovations.
    - p) Site constraints and impacts on adjacent buildings and uses
    - q) Appropriate to stated operating schedules
  - 2. Campus Site Utilities:
    - a) All buildings on the University Park Campus (UPC) or Health Sciences Campus (HSC) shall connect to University Utilities available in the area. This must be coordinated with FPM Engineering. A formal request must be made by the design team to FPM Engineering within 2 weeks of the start of Plumbing design to ascertain what University utilities are available in the area. The request must include an estimated building utility load for each utility in the form of a chart as follows:

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Service	Capacity required by building	Performance Characteristics	FPM Engineering Comments
Domestic cold water	____ WSFU ____ GPM		Available Supply Pressure at site will be ____ psi.
Sewer	____ DFU		Available POC(s)
Storm Drain	____ Sq. Ft.		Available POC(s)
Natural Gas	____ CFH		Available POC(s)

- b) See Installation portion of this section for Building Utility connection details.
- 3. Campus Building Management System Connections:
  - a) For design parameters for the building management system, see the independent controls guidelines and coordinate with campus controls vendor.
  - b) Equipment specified to have an independent on-board manufacturer-provided control system shall be connected to campus BMS system for monitoring. Coordinate with campus controls representative.
  - c) In new buildings, or when replacing existing domestic hot water supply equipment, install a hot water supply temperature sensor that may be utilized by the campus BMS system to trend hot water supply temperature.
- 4. Building Information Modeling:
  - a) The University requires manufacturers to provide BIM specific objects for final as-built documentation of all plumbing equipment and fixtures requiring service and/or containing motors.

## 2. PROCEDURAL REQUIREMENTS

- A. Standards and Code Requirements
  - 1. Required:
    - a) The Plumbing systems shall comply with the current California Code of Regulations, Title 24, the standards of ASHRAE, SMACNA, IAPMO and NFPA, as well as the requirement of the local authorities having jurisdiction.
    - b) Any updates to applicable codes (or appropriate industry standards) not reflected, or somehow violated in the current version of this guideline, shall be brought to the attention of FPM Facilities for clarification and subsequent corrections to the language presented here within.
  - 2. Preferred:
    - a) If any sections of this guideline are found to conflict with one another, formal clarification shall be requested from FPM Facilities. While request is under consideration, the design team shall assume that the stricter requirement / standard of care should apply.

## USC DESIGN GUIDELINES

3. Disallowed:
  - a) This guideline is not to be considered as a means or implied approval to violate local and state general building or trade codes.
- B. Design Criteria
  1. Required:
    - a) Provide seismic restraints for each mechanical equipment and piping systems in accordance with applicable codes and guidelines.
    - b) For liquid filled steel pipe, use the following guidelines: SMACNA "Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping" latest edition.
    - c) All plumbing fixtures/equipment and components shall be UL listed and LA City approved or IAPMO listed.
    - d) Provide Riser Diagrams (Waste & Vent, Hot & Cold Water, Storm Drain, Gas, & other piping systems) for multi-level projects.
  2. Preferred: None
  3. Disallowed:
    - a) Seismic Restraints shall not void or degrade the specified performance of the equipment's vibration isolators, where isolators are used. Refer to Section 13 48 00 for equipment vibration isolators.
    - b) Isometric Diagrams for multi-level projects.
- C. Calculation Requirements
  1. Cold and Hot water, including pipe sizing table based on WSFU/GPM.
  2. Natural Gas sizing criterion and sizing table based on CFH.
  3. Rainfall data for sizing storm and overflow drain systems based on square footage.
  4. Waste and vent sizing table based on DFU values.
- D. Quality Assurance requirements beyond standard 1 year warranty: see specific product sections.

### 3. PRODUCT REQUIREMENTS

- A. Refer to all product based sections

### 4. INSTALLATION DESIGN REQUIREMENTS

- A. General
  1. Required:
    - a) Any connections to University utilities shall have FPM Engineering approval.
    - b) Ensure maintenance and accessibility provisions for servicing and replacement.
    - c) Provide adequate working area around equipment for service.
    - d) Where Plumbing units are roof mounted or require roof opening, verify that all structural provisions are made to assure adequate capacity for load bearing and diaphragm capacity.
    - e) There shall be permanent access to the roof if any equipment needing service is mounted to the roof. This access path shall allow for removal of

## USC DESIGN GUIDELINES

- major / large equipment components through the building so as to avoid the need for specialized rigging equipment whenever major service is required.
- f) Provide Utility connections: Plumbing Site Plan
  - g) Where active fluid piping are routed through STC rated interior wall partitions use University approved Acoustics Isolators/ mounts (I.E., Clamps, Liner, Brackets and Struts) to minimize the transmission of noise and vibration to the wall structures. See Acoustics and Vibration Section 13 48 00 for the list of the STC rated partition walls.
  - h) All plumbing equipment that is not wall-mounted (e.g. on grade, on floor and on roof) shall be installed on a minimum 4" high concrete housekeeping pad.
  - i) Where plumbing equipment is located at grade level and/or in an open public accessible area, a fence/gate/etc. shall be provided for security and/or visibility purposes. Coordinate requirements with FPM Engineering. Refer to Section 01 8316.
  - j) Do not route any plumbing piping over any electrical rooms.
- 2. Preferred: No Preferences.
  - 3. Disallowed: None.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: See individual product specification sections for which items are to be commissioned or tested.
- B. Documentation required:
  - 1. See individual product specification sections for specific documentation.
  - 2. Commissioning reports: All Plumbing equipment using or converting energy from any source (i.e. electricity, gas, campus utilities) shall fall under the scope of the Commissioning process and be subject to the protocols listed in the independent Commissioning guidelines.
  - 3. Operations and Maintenance Manuals: shall be provided as required by the independent Close-out Guidelines
  - 4. Controls information: shall be provided as required by the independent controls Specifications.
- C. Required testing protocols:
  - 1. Code-required Pressure tests for all systems

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 22 1000 PLUMBING PIPING AND PUMPS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 22 00 00, 22 11 00, 22 13 00, 22 14 00 and 23 05 14.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a. For each type and size of pump specified. Include certified performance curves with operating points plotted on curves and rated capacities of selected models, furnished specialties and accessories
    - b. Provide pump calculation along with summary rationale to FPM Engineering for review on domestic water booster pumps, sewage ejection pumps and/or storm water ejection pumps.
  - 2. Preferred: Where emergency power is available, provide emergency power where applicable.
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS

- A. General Requirements:
  - 1. Required: No requirements
  - 2. Preferred: Non-submersible pumps and submersible pumps are allowed on case by case basis based on project needs.
  - 3. Disallowed: None
- B. Sewage pumps
  - 1. Required:
    - a. Vertical column Sewage ejectors complete with motors, controls and accessories to make a fully automatic system.
    - b. Factory-assembled and –tested.

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- c. Duplex at 100% redundancy.
- d. The impellers shall be non-clog design incorporating top repelling vanes to minimize pressure against the lower bearing assembly and keep solids from being trapped between impeller and casting, and shall be made of bronze.
- e. Intermediate and Casing Bearings: Grease lubricated, spaced a maximum of four (4) feet apart. Housing shall contain double bronze sleeve bearings with grease reservoir between them.
- f. Thrust Bearings: Grease lubricated adjustable ball type housed in an elevated, sealed chamber.
- g. Pumps shafts shall be solid continuous AISI 416 stainless steel. Stub or tapered shafts shall not be considered equal.
- h. The shaft hanger pipe assemblies, discharge legs, and floor plates shall be galvanized or zinc dichromate plated.
- i. Motors shall be heavy duty. NEMA Standard, TEFC enclosure with flexible coupling.
- j. The pump manufacturer shall warrant the pumps being supplied to the University against defects in workmanship and material for a period of five (5) years under normal use, operation and service.
- k. Control panel: UL 698a labeled and listed intrinsically safe control panel, for wall mounting, containing fused through-the-door disconnect switches, across-the-line magnetic starters, test-off-automatic switches, running lights, electrical alternator, and 115 volt CC transformer.
- l. In-sump controls shall be four (4) mercury float switches, UL listed. Top switch is for high water alarm. Provide wall/cover mounting bracket on 1" galvanized support pipe.
- m. The sump basin shall be constructed of concrete. Cover and curb frame shall be furnished by pump manufacturer. Sump frame covers shall be hot dip galvanized. Lid shall be air-tight.
- n. Basin shall be cleaned thoroughly with all water and debris removed prior to installing the pumps
- o. Provide separate conduits for power and sensor cables.
- p. Provide remote-mounted alarm panel, consisting of a single NEMA 1 enclosure complete with 3 indicating lights, reset buttons, alarm horn or bell, and silencing switch. Subsequent alarm shall sound even after initial alarm is silenced. Lights shall be normally dim-glow and shall change to full-glow and sound the alarm under any of the following conditions:
  - 1) Power failure to the pump control panel.
  - 2) High water condition.
  - 3) Simultaneous two pump operation or failure of either pump.
  - 4) The panel shall be provided with a dry contact for high water level alarm signal to a Building Management System (BMS) where available.
- q. Pump Discharge Piping: Factory or field fabricated, ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe
- r. Provide appropriate control modules so specific control and monitoring points can be hardwired directly from equipment to BMS including start/stop, stats, and alarm. Coordinate with FPM Facilities for identification of specific points required.

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- s. The entire system shall be capable of being monitored by the campus BMS interface and all data shall be provided in an open protocol with all necessary BacNet or Modbus gateways provided free of charge.
  - t. Submersible pumps shall be provided with guide rail support systems for access to pumps.
  - 2. Preferred: Manufactured by Grundfos, Ebara International Corp., Delta "Q" Pump Company and Tramco Pump Technology.
  - 3. Disallowed: None
- C. Sump pumps
- 1. Required:
    - a. Vertical column sump pumps complete with motors, controls and accessories to make a fully automatic system.
    - b. Factory-assembled and tested.
    - c. Duplex at 100% redundancy.
    - d. The impellers shall be multi-vane type and shall be made of cast iron.
    - e. Thrust bearings: Grease lubricated adjustable ball type housed in an elevated, sealed chamber.
    - f. Pump shafts shall be solid, continuous AISI 416 stainless steel. Stub or tapered shafts shall not be acceptable.
    - g. The shaft hanger pipe assemblies, discharge legs, and floor plates shall be galvanized or zinc dichromate-plated.
    - h. Motors shall be heavy duty, NEMA Standard, TEFC enclosure, with flexible coupling.
    - i. The pump manufacturer shall warrant the pumps being supplied to the University against defects in workmanship and material for a period of five (5) years under normal use, operation and service.
    - j. Control panel: UL 508 labeled and listed control panel, for wall mounting, containing fused through-the-door disconnect switches, across-the-line magnetic starters, test-off-automatic switches, running lights, electrical alternator, and 115 volt CC transformer.
    - k. In-sump controls shall be four (4) mercury float switches, UL listed. Top switch is for high water alarm. Provide wall/cover mounting bracket on 1" galvanized support pipe.
    - l. The sump basin shall be constructed of concrete. Cover and curb frame shall be furnished by pump manufacturer. Sump frame covers shall be hot dip galvanized. Lid shall be air-tight.
    - m. Basin shall be cleaned thoroughly with all water and debris removed prior to installing the pumps
    - n. Provide separate conduits for power and sensor cables.
    - o. Provide remote-mounted alarm panel, consisting of a single NEMA 1 enclosure complete with 3 indicating lights, reset buttons, alarm horn or bell, and silencing switch. Subsequent alarm shall sound even after initial alarm is silenced. Lights shall be normally dim-glow and shall change to full-glow and sound the alarm under any of the following conditions:
      - 1) Power failure to the pump control panel.
      - 2) High water condition.
      - 3) Simultaneous two pump operation or failure of either pump.
      - 4) The panel shall be provided with a dry contact for high water level alarm signal to BMS where available.



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- p. Pump Discharge Piping: Factory or field fabricated, ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe
  - q. Provide appropriate control modules so specific control and monitoring points can be hardwired directly from equipment to Building management System (BMS) including start/stop, stats, and alarm. Coordinate with FPM Facilities for identification of specific points required.
  - r. The entire system shall be capable of being monitored by the campus BMS interface and all data shall be provided in an open protocol with all necessary BacNet or Modbus gateways provided free of charge
  - 2. Preferred: Manufactured by Grundfos, Ebara International Corp., Delta "Q" Pump Company and Tramco Pump Technology.
  - 3. Disallowed: None
- D. Hot Water circulating pumps
- 1. Required:
    - a. In-line direct couple single speed ODP electrical motor
    - b. Shall comply with AB1953
    - c. Hot water circulating pumps over 1.5 hp shall have cast iron bodies. Pumps 1.5 hp and less shall have hard bronze water chambers and impellers
    - d. To be furnished with "Intermatic" 7/24 digital time clock and aquastat.
  - 2. Preferred: Grundfos Magna, no known equal.
  - 3. Disallowed: None
- E. Domestic water booster pumps
- 1. Required:
    - a. The packaged water booster pump system shall be a standard product of a single pump manufacturer.
    - b. The complete packaged water booster pump system shall be certified and listed by UL.
    - c. The packaged booster pump system shall use advanced variable frequency drive and electronic controller technology to maintain a constant pressure at desired flow.
    - d. Number of pumps in package should be selected per project requirements.
    - e. The impellers, pump shaft, diffuser chambers, outer discharge sleeve, impeller seal rings and seal ring retainers shall be constructed of stainless steel.
    - f. Shall comply with AB1953.
  - 2. Preferred: Grundfos, VC Systems & Controls, Inc., Delta "Q" Pump Company.
  - 3. Disallowed:
    - a. Pump systems that use pump control valves or pressure reducing valves to maintain a constant water pressure.

## 4. INSTALLATION REQUIREMENTS

- A. Sewage pumps
- 1. Required:
    - a. Install sewage pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings and accessories.
    - b. Install discharge piping equal to or greater than size of pump discharge piping.

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- c. Install vent piping to terminate to atmosphere (above roof outside of building).
    - d. Install check and gate valves on discharge piping from each pump. Install valves same size as connected piping.
    - e. If submersible sewage ejectors allowed, provide with Quick-Disconnect and Guide-Rail.
  2. Preferred: No preferences
  3. Disallowed: None
- B. Sump pumps
  1. Required:
    - a. Install sump pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings and accessories.
    - b. Install discharge piping equal to or greater than size of pump discharge piping.
    - c. Install vent piping to terminate to atmosphere (above roof outside of building).
    - d. Install check and shutoff valves on discharge piping from each pump. Install valves same size as connected piping.
    - e. If submersible sump pump allowed provide with Quick-Disconnect and Guide-Rail.
  2. Preferred: No preferences
  3. Disallowed: None.
- C. Hot water circulating pumps
  1. Required:
    - a. Install pump with union connections for maintenance and replacement.
    - b. Provide 24/7 time clock, thermometer and aquastat.
  2. Preferred: Locate said pump, mounted on wall adjacent to water heater.
  3. Disallowed: At ceiling.
- D. Domestic water booster pumps
  1. Required:
    - a. Install booster pumps on concrete base using neoprene pads.
    - b. Support connected domestic-water piping so weight of piping is not supported by booster pumps.
    - c. Engage a factory-authorized service representative to perform startup service.
    - d. Install suction and discharge pressure gages and shut-off valves.
    - e. Adjust booster pumps to function smoothly and lubricate as recommended by manufacturer.
  2. Preferred: No preferences
  3. Disallowed: None

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### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Code-required Pressure tests for all systems.
  
- B. Documentation required:
  - 1. Pressure Test reports.
  - 2. Test and adjust controls and safeties
  - 3. UL listing: all pumps.
  - 4. Lead-free pumps: All fixtures, pipes and plumbing fitting that intended to convey or dispense water for human consumption through drinking or cooking.
  
- C. Required testing protocols:
  - 1. Code-required Pressure tests for all systems.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 22 1100 FACILITY WATER DISTRIBUTION

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 22 00 00, 22 10 00, 22 34 00 and 22 40 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a. Maximum flow for fixtures must comply with City of Los Angeles water conservation guidelines and ordinances
    - b. Conceal and properly secure all piping behind building finishes. Exception, exposed piping may be acceptable in equipment and custodial rooms when first approved. Where necessary and approved, exposed piping in renovation projects shall be painted. Insulate hot water and condensate piping.
    - c. Allowable water velocity shall be 5 feet/second for hot water and 6 feet/second for cold water in copper and non-metallic piping.
    - d. Size hot-water circulating pump and piping for water velocity not to exceed 5 feet/second.
    - e. In new buildings with commercial kitchens, provide can wash for cleaning of garbage cans. Provide domestic cold and hot water at can wash stations. Hot water supply only where possible and feasible.
    - f. In new buildings, or when replacing existing domestic hot water supply equipment, install a hot water supply temperature sensor that may be utilized by the campus BMS system to trend hot water supply temperature.
    - g. Victaulic piping systems for plumbing shall be first approved prior to installation on a case by case base by FPM Facilities.
  - 2. Preferred: Soldered/Brazed with Wrought copper fittings.
  - 3. Disallowed:
    - a. Pro-press fittings are not allowed.
    - b. T-DRILL methods for branch piping is not allowed.
    - c. No hot taps, unless first approved.

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- B. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS

A. General Requirements

1. Required
  - a. Material requirements

<i>Service</i>	<i>Size</i>	<i>Location</i>	<i>Material</i>	<i>Joining Method</i>
Domestic Cold Water	All	Underground	Rigid Copper (Type K)	Brazed
Domestic Cold Water	All	Above Ground	Rigid Copper (Type L)	Soldered
Domestic Hot Water	All	Underground	Rigid Copper (Type K)	Brazed
Domestic Hot Water	All	Above Ground	Rigid Copper (Type L)	Soldered
Domestic Hot Water Return (Housing projects only)	All	Above Ground	Rigid Copper (Type K)	Soldered
Domestic Hot Water Return (all other projects)	All	Above Ground	Rigid Copper (Type K)	Soldered

2. Preferred: Domestic Made.
3. Disallowed: None.

B. Domestic Water Piping

1. Required:
  - a. Coordinate with civil engineer to define and request water service from utility supplier.
  - b. All domestic water supply mains shall be designed with an above-ground valve station. The station shall include a reduced pressure principal backflow preventer (verify with FPM Engineering) with strainer and when the street pressure exceeds 80 psig, a two-station minimum pressure regulator with strainer shall be provided.
  - c. A separate service (verify with FPM Engineering) shall be provided for landscape irrigation, with a reduced pressure principle back flow preventer and strainer.
  - d. Pressure regulating valve (PRV) stations shall include a minimum of two university approved direct acting regulators with strainers. Valves shall be flanged and sized to provide uninterrupted service to the building when the valves are being serviced. In addition, provide a by-pass valve normally closed and lockable. Services over 4 inches require a third, smaller PRV for constant low-flow demands.
  - e. Use backflow prevention valves having the lowest possible friction loss.
  - f. Provide sub-meter (water) for new projects as directed by FPM Facilities. Sub-meter shall be connected to USC BMS.
  - g. Provide water service to all fixtures and outlets, designed in accordance with National Bureau of Standards Reports 66 and 79 with not less than 30 psi at farthest and highest fixture or the pressure required for the highest and

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- farthest flushometer-operated water closet to operate properly or Emergency shower/eyewash station on roof, whichever is predominant.
- h. Size pipe, base on the number of fixture units and demand load curves in the current California Plumbing Code.
  - i. Outside Stem and Yoke (OS & Y) valves may be used in equipment rooms at seven (7) feet or higher for visual identification of Open or Closed conditions. In such cases provide a chain operator to allow for operating the valve without a ladder.
  - j. Pitch piping as required for proper drainage and flow and elimination of air.
  - k. Provide Water Hammer Arrestors within wall, behind access panel for lavatories, sinks, fountains, water closets, urinal headers and other fixtures or devices with quick closing valves, such as clothes washers.
  - l. Each faucet shall have its own angle stop. No angle stop should serve more than one faucet at a time.
  - m. If feasible, for industrial water needs, provide designated industrial cold water system.
  - n. Provide hose bibb/wall hydrant in the following areas:
    - Perimeter of building, 150 ft. on center
    - Roof for mechanical equipment.
    - Provide reduce pressure backflow preventer upstream of hose bibbs in Mechanical Rooms with sewage/sump pumps.
2. Preferred:
    - a. Reduce pressure backflow preventer, 2" and smaller shall be "Apollo" RPLF4A Series. No Exception.
    - b. Sub-water meter – Zenner lead free Model PPD, Sizes; 1", 1-1/2" and 2". Zenner lead free Model ZTMB, Sizes; 3", 4" & 6". Provide sub-meters with Zenner ETRU Encoded Type Register and MCS SB-PL-50 pulse lengthener. Install submeters per manufacturers recommendations. Contact: Measurement Control Systems, (818) 826-1682.
  3. Disallowed:
    - a. Do not run water lines under slab if at all possible or first approved.
    - b. Water hammer arrestors above ceiling.
- C. Hot Water and Hot Water Return Piping
1. Required:
    - a. Follow all requirements listed under Domestic Water piping section above.
    - b. Circulating hot water pumps shall be put on a time clock and controlled so they will operate only when the building is occupied. Contractor shall coordinate with PM for building operations.
    - c. When Circulation pump connection requires a reduction in size, it shall be made as close as possible to the pump.
    - d. Insulate hot water return lines as required for domestic hot water systems.
    - e. Hot water to be provided with single mixing valve station for 120°F hot water distribution.
    - f. Minimum for hot water return piping shall be 3/4" pipe.
    - g. Where multiple return lines are provided, furnish circuit setters or circuit solvers with shut-off valve and check valve up-stream and shut-off valve downstream.
  2. Preferred: Mixing Valve: Rada ("Armstrong) Digital. No factory pre-piped assembly. Provide with manufacturer specified by-bass.

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3. Disallowed:
  - a. Avoid running dead-leg piping over 10 feet circulation system.
  - b. Avoid having multiple hot water mixing valve stations throughout building.
  - c. No 1/2" pipe size for hot water return piping.
  - d. No manual balancing valves.

### 4. INSTALLATION REQUIREMENTS

#### A. Domestic Water Piping

1. Required:
  - a. Install pressure regulating valves with strainers when the street line pressure is over 80 psig to reduce pressure to approximately 79 psig maximum.
  - b. Provide removable gages with ball valves for isolation stops on both inlet and outlet valve stations (for inlet pressure and reduced pressure).
  - c. Provide an epoxy coated wye strainer ahead of regulators.
  - d. Locate pressure regulating assemblies and strainer assemblies above grade in a shielded enclosure and in a serviceable area. Manufacturer: Watts, Wilkins or first approved by FPM Engineering.
  - e. Use reduced-pressure principal backflow assemblies for main line domestic (Laboratory Buildings only) and irrigation services for meter protection.
  - f. Reduce pressure backflow preventer, install in accessible location for testing and maintenance, provide adequate drainage for relief discharge, flush system piping after installation, install in horizontal position and height shall comply with code.
  - g. Vacuum breakers or other required reduced pressure backflow prevention valves which are required but not limited to the following locations:

All flush valves	Animal drinking devices
Direct connections to boilers and tanks	Cooling Towers and evaporative coolers ( or provide air gap)
Water-cooled refrigerator condensers	Up-stream of Hose Bibb at Sewage and sump pumps.
Soft drink dispensers	Fire Sprinkler Systems
Hose bibs and still cocks. All laboratory equipment	Irrigation Systems
Various types of processing equipment ( Check with City of LA)	

- h. All shut-off valves shall be accessible from the room in which fixtures are installed and shall be located at approx. 3'-0" but no more than 5'-0" from the finished floor. These valves shall control only fixtures in the room in which they are installed.
- i. Provide shut-off valves in the following locations:

Each group of fixtures.	Each laboratory or preparation room
Each restroom	Each building, located at the entering point of the building with yard box.
Each floor of each building	

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- j. Use gate or ball valves for plumbing isolation shut-off.
  - k. Provide a ball valve to isolate all fixtures in each restroom, laboratory, kitchen and any other room with multiple fixtures. Valves shall be in recessed boxes with locking covers, located above the upper terminal water closet for restrooms and above fixtures in other areas.
  - l. If backflow prevention devices are located in areas where there are occupants, provide flood protection valve for these devices.
  - m. In new buildings, a water hammer test for cold and hot water piping shall be performed.
  - n. Provide chained engraved red tag with white lettering on all main utility line building shut-off valves (gas, water, etc.) to designate, "Building Shut-off Valve".
- 2. Preferred: Valves
    - a. 2" & smaller: Apollo 77CLFA series full port ball valves with stainless steel ball and stem
    - b. 2-1/2" & Larger: Apollo 77CLFA series full port ball valves with stainless steel ball and stem.
    - c. 2-1/2" & larger: Nibco 619 NRSRW series, resilient wedge, epoxy coated ductile iron gate valve.
  - 3. Disallowed: Red & White Valves.
- B. Hot water and hot water return piping
    - 1. Required:
      - a. Install straight length of pipe without bends or restrictions at least 10 diameters long on the suction side of all pumps unless inlet diffusers are used.
      - b. Provide a check valve after the pump, for the hot water return line.
      - c. Provide circuit setter assembly with shut-off valve on each return branch if 2 or more branches served by single circulating pump.
    - 2. Preferred: No preferences
    - 3. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Code-required Pressure tests for all systems.
- B. Documentation required:
  - 1. Pressure Test reports.
  - 2. UL listing: Hot water pumps.
  - 3. Lead-free fixtures: All fixtures, pipes and plumbing fitting that intended to convey or dispense water for human consumption through drinking or cooking.
- C. Required testing protocols:
  - 1. Code-required Pressure tests for all systems.

END OF DOCUMENT



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## 22 1100.1 CONSTRUCTION WATER MONITORING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to water monitoring specifically related to temporary water for use during construction activities.
  - 2. Preferred: None
  - 3. Disallowed: None
- B. All equipment, engineering, and commissioning services shall be from one manufacturer with equipment being UL approved.

### 3. PRODUCT REQUIREMENTS

- A. Water Metering Components:
  - 1. Water Meter: Omega Water Totalizer
    - a) Model No (FTB-632P, FTB-633P, FTB-634P, FTB-635P, FT-636P, or FTB638P) depending on the size.
  - 2. Onset Remote Monitoring Station
    - a) Provide (1) Onset Remote Monitoring Station Model #RX3001-00-01
    - b) Provide (1) power supply adapter to supply Onset Remote Monitoring Station 6vdc.
    - c) Provide 3 each of electronic stitch pulse input adapter: Onset #S-UCC-M006
    - d) Where a power meter is also being installed for construction purposes, only one Onset Remote Monitoring Station is required. Coordinate with FPM Facilities prior.

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### 4. INSTALLATION REQUIREMENTS

#### A. INSTALLATION

1. Water meter shall be installed by a certified plumber.
2. Water meter installation must meet the City of Los Angeles latest plumbing code.
3. Two-wire shall be terminated from the water meter to the Onset Remote Monitoring Station.
4. Water meter must be fitted in the right direction of flow and positioned to allow easy visibility for manual reading.

#### B. FIELD QUALITY CONTROL

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections and to assist in testing.

#### C. TEST AND INSPECTIONS:

1. Water Meter information that is required to be submitted by the contractor to FPM Facilities is as follows:
  - a. The exact location of the meter.
  - b. The date the meter was installed and the make, size, type and serial number of the meter.
  - c. Photograph, and/or diagram of meter fitted on pipe-work, including dimensions showing lengths of clear pipe before and after water meter up to the first take-off.
  - d. The meter reading at the time of installation.

### 5. EVALUATION or COMMISSIONING

- A. Onset Remote Monitoring commissioning shall be witnessed by FPM Facilities. Contractor shall demonstrate the following items:
  1. All wiring is safely terminated.
  2. Onset Remote Monitor powers up.

**END OF DOCUMENT**

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## 22 1300 FACILITY SANITARY SEWERAGE

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 22 00 00, 22 10 00 and 22 40 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X		X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a. Piping materials shall bear manufacturer's name or manufacturer's registered trade-mark stamp, country of origin and other markings of specified testing agency.
    - b. Components and installation shall be capable of withstanding 15psig working-pressure.
    - c. Designed system shall comply with City of LA and CPC latest edition requirements.
    - d. Industrial Wastewater Permits must be obtained from the City of Los Angeles Department of Public Works, Bureau of Sanitation, Industrial Waste Management Division, in accordance with the Los Angeles Waste Control Ordinance for all universities. A permit is required for each point of discharge to the City's sewer system. (For other jurisdictions the local ordinance must be addressed, the standards required by the City of Los Angeles shall be the minimum standard for all University Buildings).
    - e. When private disposal systems are required and programmed, verify requirements with the local health authorities and obtain written approval. Clearly define the extent and locations of systems elements.
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None required

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### 3. PRODUCT REQUIREMENTS

#### A. Product Requirements

1. Required:
  - a. Material requirements

Service	Size	Location	Material	Joining Method
Sanitary Waste Sewer	All	Underground	Cast Iron Soil Pipe & Fittings, ASTM A 888-15 or CISPI 301-12	Hubless
Sanitary Waste Sewer	All	Above Ground	Cast Iron Soil Pipe & Fittings, ASTM A 888-15 or CISPI 301-12	Hubless
Sanitary Waste Vent	All	Above Ground	Cast Iron Soil Pipe Fittings, ASTM A 888-15 or CISPI 301-12	Hubless
Sanitary Waste Sewer (Pressurized)	All	Above Ground	Schedule 40 Galvanized Steel	Screwed
Grease Waste & Vent	All	Underground Above Ground	Cast Iron Soil Pipe & Fittings, ASTM A 888-15 or CISPI 301-12	Hubless

- b. Piping grade or slope criteria for complete drainage and venting

Type of Piping	Slope	Direction of Fall
Sanitary Waste Sewer	1/4" per 1'-0"	Down in direction of flow. 1/8" per 1'-0" slope is not allowed unless approved by FPM Engineering

- c. Provide Holdrite Series 117 no-hub fitting restraint on cast iron pipe joints against separation during high thrust conditions.
      - d. Transitional fittings on change of pipe sizes.
      - e. Branch line waste & vent piping serving floor sinks taking drainage from soda machines shall be as follows:
        - i. Below Ground: Polypropylene
        - ii. Above Ground: PVDF

2. Preferred: No preferences
  3. Disallowed: None.

#### B. General Requirements

1. Required:
  - a. Food kitchen areas shall comply with the City of Los Angeles' Fats, Oil and Grease (FOG) Control Program. Consult and obtain the approval of Bureau of Sanitation.
  - b. Grease interceptors shall comply with the City of Los Angeles' Plumbing Code, and must be provided for all grease-producing equipment (pot sinks,

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- floor drains, floor sinks, prep sinks and mop sinks within the kitchen preparation area are to be tied to the grease interceptor).
- c. Where floor drains are required, slope floor to drain at 1/8" per foot.
  - d. Floor drains and floor sinks with trap primers are required at:
    - i. Restrooms, one floor drain shall be provided front and center for two or more urinals, one floor drain is required for water closets in all restrooms with an additional floor drain when a total of four or more water closets are provided.
    - ii. Shower and locker rooms and adjacent drying rooms.
    - iii. Custodian closet- Located floor drain near mop/service sink.
    - iv. Mechanical rooms, Equipment rooms. Coordinate with FPM Engineering.
    - v. Uncovered trash areas. These areas are required to be provided with a special floor drain system that normally drains to the storm system but diverts the drainage to the sewer system when the trash containers are being washed, using a special valve system.
    - vi. Kitchens, Walk-in Coolers and freezer-boxes.
    - vii. Areas required by the California Plumbing Code and the Los Angeles City Plumbing Code.
    - viii. Can Wash Areas: Drain shall drain to site grease interceptor.
    - ix. In new ground-up projects and major remodels, provide floor drains in the vicinity of new emergency shower/eyewash stations. For projects in existing buildings, at existing emergency shower/eyewash stations to remain, a floor drain is not required but a flow switch is required at the supply line. The flow switch shall be monitored by DPS and alarmed by campus building management system or fire alarm system. Please coordinate with FPM Engineering prior for availability.
  - e. In subterranean parking garage, provide an adequately sized emergency drain for every 4000 sq. ft. Within ten feet around the floor drain provide 1/8" foot slope of drain.
  - f. Waste Piping Traps – All parts of traps shall be cast brass with polished Chromium plated finish. Tubular traps are not allowed.
  - g. Interceptors and separators must be located and installed so they are easily accessible for inspection, cleaning and removal of intercepted material.
  - h. Underground waste piping with 90 degrees or greater change in direction, shall provide a cleanout to grade.
3. Preferred: Highland Tank Passive Grease Interceptor/Jensen Pre Cast Grease Interceptor.
  2. Disallowed: Automatic grease interceptor unless directed otherwise by FPM Facilities.
    - a. Elevator pit drains are not required.
    - b. Combination waste/vent piping is not allowed on UPC or HSC (Health Science Campus)
    - c. Vertical/Horizontal wet venting system is not allowed.

## USC DESIGN GUIDELINES

### 4. INSTALLATION REQUIREMENTS

- A. Required:
1. Provide clean-outs above all urinals, lavatories, upper terminal water closets and sinks.
    - a. For water closets, a cleanout shall be provided at the end of run for two or more water closets. Cleanout shall be located 4-6" above the flood level of the water closets.
    - b. For urinals, a cleanout shall be provided above the flush valve for each urinal and at the end run of two or more urinals (located 4-6" above flood level of urinals).
    - c. For lavatories, a cleanout shall be provided at the end run above counter or at counter height if there is interference with a mirror.
  2. Avoid locating cleanouts in ceiling/attic /plenum spaces. If possible, locate cleanouts in a wall with access panel above the ceiling/attic /plenum spaces.
  3. Provide cleanouts to grade in yard box at:
    - a. Upper terminal cleanout within 5 feet of building line connection
    - b. Every 50 feet or change in direction over 135 degrees
    - c. At property line connection
  4. Sewage pit shall be lined with high-density polyethylene (HDPE).
  5. Sewage Ejections System control panel shall have equipment markings (tags).
  6. Access to sewage ejection pumps and control panel shall be 3' clear.
  7. All condensate and indirect waste piping from air handling/fan coil units located above ceiling/concealed locations shall be insulated with fire rated insulation to its point of discharge.
  8. Vent piping from grease interceptor shall be independent and terminate above the roof line with an odor filter.
- B. Preferred: No preference
- C. Disallowed: None.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:
1. Facility Sanitary Sewer
- B. Documentation required:
1. Test reports per CPC City of LA FOG Control program.
  2. Commissioning report:
- C. Required testing protocols behind normal balancing and commissioning procedures:
1. Code required test for waste and vent systems.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 22 1400 FACILITY STORM DRAINAGE

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 22 00 00 and 22 10 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X		X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Piping materials shall bear manufacturer's name or manufacturer's registered trade-mark stamp, country of origin and other markings of specified testing agency.
    - b) Components and installation shall be capable of withstanding 15psig working-pressure.
    - c) Designed system shall comply with City of LA and CPC latest edition requirements.
    - d) Hourly rainfall intensity to match City of LA requirements.
    - e) Maximum area served by any single drain must be no more than 6,000 square feet of roof surface.
  - 2. Preferred:
    - a) No preferences
  - 3. Disallowed:
    - a) None.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.

## USC DESIGN GUIDELINES

### 3. PRODUCT REQUIREMENTS

#### A. General Requirements:

1. Required:
  - a) Material Requirements

Service	Size	Location	Material	Joining Method
Storm Drain	All	Underground	Cast Iron Soil Pipe & Fittings, ASTM A 888-15 or CISPI 301-12	Hubless
Storm Drain	All	Above Ground	Cast Iron Soil Pipe & Fittings, ASTM A 888-15 or CISPI 301-12	Hubless

- b) Piping grade or slope criteria for complete drainage and venting

Type of Piping	Slope	Direction of Fall
Storm Drain	1/4" per 1'-0"	Down in direction of flow. 1/8" per 1'-0" slope is not allowed unless approved by FPM Engineering

2. Preferred: No preferences
3. Disallowed: None

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. Slope storm and overflow drain pipe downward in direction of flow as required by code and per authority having jurisdiction.
2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers.
3. Provide additional cleanouts using City of Los Angeles Plumbing Code as reference.

#### B. Preferred:

1. No preference.

#### C. Disallowed:

1. Combining of storm and overflow drain is prohibited.



## USC DESIGN GUIDELINES

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:
  - 1. Test storm drainage piping as follows:
    - a) Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
    - b) Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
    - c) Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 15 psi of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
    - d) Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
    - e) Prepare reports for tests and required corrective action.
- B. Documentation required:
  - 1. Test reports
- C. Required testing protocols:
  - 1. Code required test

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 22 1600 SPECIAL LABORATORY PLUMBING SYSTEMS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 22 00 00, 22 11 00 and 22 70 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a. All piping, fittings, valves, outlets and any equipment through which medical/laboratory gas or vacuum passes shall be supplied by the manufacturer especially cleaned and prepared for medical gas service in accordance with CGA Pamphlet G-4.1 and received labeled and sealed on the jobsite. On-site cleaning is not acceptable. Any prewashed item on which the seal has been broken before installation shall be removed from the site and shall not be used on this project.
    - b. Copper tubing fittings: Wrought copper solder-joint pressure fittings for brazed joints, ANSI Designation B16.22
    - c. Valves: Union type three-piece construction, screwed, 400 lb. rated, with Teflon seat, seals, packing and chrome plated brass ball with service identification on valve handle
    - d. Brazing alloy and thread sealant: Brazing filler metal ANSI/AWS A5.8 with a melting temperature in excess of 1000°F (538°C).
    - e. Acid waste and vent system shall be installed in accordance with the latest City of Los Angeles Plumbing Code and Los Angeles Department of Public Works, Bureau of Sanitation. Confirm that product has associated Los Angeles City Research Report Number (LARR#).
    - f. Backflow devices at every piece of equipment requiring RO or DI water supply system
  - 2. Preferred:
    - a. Provide natural gas outlets in laboratories if natural gas available in the designed building.
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.

## USC DESIGN GUIDELINES

### 3. PRODUCT REQUIREMENTS

#### A. General Requirements:

1. Required:
  - a. Material Requirements

Service	Size	Location	Material	Joining Method
Oxygen, Nitrogen, Medical/Laboratory Air, Medical/Lab Vacuum and Carbon Dioxide	All	Underground	Seamless Medical Gas Copper Tubing (Type K)	Brazed
Oxygen, Nitrogen, Medical/Laboratory Air, Medical Vacuum and Carbon Dioxide	All	Above Ground	Seamless Medical Gas Copper Tubing (Type L)	Brazed
Liquid Nitrogen	All	Above Ground	Insulated Schedule XS 304 L Stainless Steel	
Acid Waste and Vent (All piping excluding trap under lab sink)	All	All	Schedule 40 PVDF	Heat fusion fitting
Acid Waste and Vent (Trap under lab sink)	All	All	Schedule 40 PVDF	Mechanical joints
RO & DI Water	All	All	High purity PVDF (SYGEF)	BCF® Joining Technology

2. Preferred: No preferences
3. Disallowed:
  - a. Glass pipe for acid waste and vent systems.

#### B. Medical/Laboratory Air Compressor

1. Required:
  - a. Duplex air compressors with 100% redundancy.
  - b. Factory-assembled, -wired, -piped and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.
  - c. Motor Overload Protection
  - d. Provide discharge-air and receiver pressure gauges, air-filter maintenance indicator, hour meter, air-compressor discharge-air and coolant temperature gauges and control transformer.
  - e. Connect to alarm system to indicate when backup air compressor is operating
2. Preferred: Manufactured by Beacon Meades, Busch

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3. Disallowed: None
- C. Medical/Laboratory Vacuum Pump
  1. Required:
    - a. Duplex vacuum pumps with 100% redundancy.
    - b. Factory-assembled, -wired, -piped and -tested; electric-motor-driven; air-cooled; continuous-duty vacuum pumps and receivers.
    - c. Motor Overload Protection
    - d. Provide vacuum pump inlet and receiver vacuum gauges, hour meter, vacuum pump discharge-air and coolant temperature gauges and control transformer.
    - e. Connect to alarm system to indicate when backup vacuum pump is operating
  2. Preferred: Manufactured by BeaconMedaes
  3. Disallowed: None
- D. Oxygen, Nitrogen and Carbon Dioxide
  1. Required:
    - a. Medical gas service connections.
    - b. Nitrogen pressure control panels.
    - c. Gas manifolds.
    - d. Medical gas alarm system components.
  2. Preferred: Manifolds manufactured by BeaconMedaes
  3. Disallowed: None

### 4. INSTALLATION REQUIREMENTS

- A. All pipes
  1. Required:
    - a. Install piping concealed from view and protected from physical contact by building occupants except in equipment rooms and service areas
    - b. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space
    - c. Install nipples, unions and special fittings and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated
    - d. Install piping to permit valve servicing.
    - e. Install piping free of sags and bends.
    - f. Install fittings for changes in direction and branch connections.
    - g. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
    - h. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.
    - i. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.
    - j. Install gas manifolds anchored to substrate
    - k. Install chain restraints for upright cylinders
  2. Preferred: No preferences
  3. Disallowed: None

## USC DESIGN GUIDELINES

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:
  - 1. Required Items:
    - a. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications and certification of medical gas piping systems concurrently with tests, inspections and certification of medical compressed-air piping and medical vacuum piping systems.
    - b. Standing pressure test for positive pressure medical gas piping.
    - c. Standing pressure test for vacuum systems.
- B. Documentation required:
  - 1. Pressure Test reports.
  - 2. Inspections performed.
  - 3. Procedures, materials and gases used.
  - 4. Test methods used.
  - 5. Results of tests.
  - 6. UL listing
- C. Required testing protocols:
  - 1. NFPA 99
  - 2. ASSE Standard #6020
  - 3. ASSE Standard #6030

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 22 3400 FUEL-FIRED DOMESTIC WATER HEATERS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 22 00 00, 22 11 00 and 23 57 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Water heaters shall be certified by the California Energy Commission and meet Title-24, AQMD Low NOx Rule 1121 and 1146.2. Water heating boilers 1,000,000 Btu.hr and larger shall be registered with South Coast Air Quality Management District (SCAQMD) per rule 222 to meet 114 6.2 requirements).
    - b) All gas fired water heaters shall meet the flammable vapors ignition resistance requirements (FVIR).
    - c) Domestic hot water shall be stored at 140°F.
    - d) Provide circulating system for hot water systems.
    - e) Use in series with equal split piped manifold to avoid the use of separate storage tanks.
    - f) Provide Kitchens with separate redundant water heaters as directed by FPM Facilities.
    - g) Install a hot water supply temperature sensor that may be utilized by the campus BMS system to trend hot water supply and storage tank (when equipped) temperatures.
  - 2. Preferred:
    - a) Preference is for steam heat exchangers. If campus steam is not available to the facility/building, a central gas-fired domestic water heater with storage tank shall be provided.
  - 3. Disallowed:
    - a) Electric water heaters should be avoided. Electric water heaters may be used as a last resort for isolated locations and in small sizes as directed by FPM Engineering.
    - b) No Heat trace piping is allowed.
    - c) Do not use multi-flue water heaters, nor booster or instantaneous type water heaters.

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- d) Instantaneous tank-less water heaters of any kind or size are prohibited unless otherwise directed by FPM Engineering. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS:

#### A. Required:

1. Commercial water heater with coated steel burners.
2. Anodes for cathodic protection.
3. Pressure and temperature relief valve shall be furnished and installed by the factory.
4. Heater tank shall have a minimum 3 year limited warranty against corrosion or sediment buildup.
5. Glass lined, foam insulated with intermittent ignition device.
6. Automatic gas shutoff system to prevent excessive water temperature.
7. Water heater shall be equipped with integrated control system consisting of 180°F adjustable thermostat with upper and lower sensing bulbs.
8. Shall have gas pressure regulator and pilot filter.

#### B. Preferred:

1. Manufactured by Bradford White Water Heaters (Housing only or where first approved by FPM Engineering).
2. Manufactured by Raypak "Hi Delta" series water heater with separate storage tank (Housing only).
3. Manufactured by PVI "Turbopower" non-condensing, low nox, stainless steel lined packaged storage type hot water heater.

#### C. Disallowed: None

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. Provide ball valve with plug at water heater drain outlet.
2. Provide seismic anchorage for all equipment.
3. Provide drip pans at all water heaters and drain the pan to an approved receptor.

#### B. Preferred: No preferences

#### C. Disallowed:

1. Do not bolt down the water heater legs.

### 5. EVALUATION or COMMISSIONING

#### A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items: water heaters

#### B. Documentation required:

1. Commissioning report.
2. South Coast Air Quality Management certificate
3. UL listing: Water heaters.

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- C. Required testing protocols:
  - 1. None.

**END OF DOCUMENT**



# USC DESIGN GUIDELINES

## 22 3500 DOMESTIC WATER HEAT EXCHANGERS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 22 00 00, 22 11 00, 22 34 00, 23 57 00 and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Calculate required size of unit to produce the output shown after deducting for scale formation of tube surfaces using a fouling factor of 0.0005.
    - b) Temperature range for operation will be a maximum of 140°F. The circulation pumps on these systems will run for a minimum of 10 minutes after the steam has been shut down to eliminate the possibility of the temperature of the exchanger exceeding the 140°F.
    - c) Steam relief valves shall be at 125 psi, at size of heat exchanger, with vents piped to the outside of the building above the roof line away from overhangs and air intakes.
    - d) Hot water relief shall be at 125 psi, at size of heat exchanger, and piped to a sanitary drain.
    - e) Storage type hot water generator.
    - f) Provide Kitchens with separate redundant water heaters as directed by FPM Facilities.
  - 2. Preferred: No preferences
  - 3. Disallowed: Remote storage tank.
    - a) Do not select unit from manufacturer's catalog rating. See above.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required

### 3. PRODUCT REQUIREMENTS

- A. Steam-to-water heat exchanger (for domestic water):
  - 1. Manufacturers:
    - a) Required: No requirements

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- b) Preferred: PVI Industries, LLC, Quickdraw Steam Semi-Instantaneous Water Heater.
- c) Disallowed: None
- 2. Component Characteristics:
  - a) Required:
    - 1) Materials of Construction:
      - i) Shell: 90/10 copper-nickel, ASME certified for 155 psig working pressure.
      - ii) Tubes: Copper or 90/10 copper-nickel double wall.
      - iii) Tube Sheet: Solid copper alloy.
      - iv) Baffles: Teflon.
    - 2) Shell Connections: Solid copper alloy
    - 3) Shall have factory installed pilot operated control valve able to control water temperature within 2 degrees of set point, T&P gauges, T&P relief valve, single solenoid safety system and be a complete factory finished unit including 3 inch thick fiberglass insulation and heavy gauge sheet steel jacket and comply with current ASHRAE standards.
    - 4) Energy Management System Interface: Normally closed dry contacts for enabling and disabling water heater.
    - 5) Boiler water thermometer (3-1/2" diameter dial minimum) direct mounted with separable thermowell.
    - 6) Domestic water thermometer (3-1/2" diameter dial minimum) direct mounted with separable thermowell.
    - 7) Control Panel:
      - i) UL listed, NEMA 4 enclosure, mounted and prewired for single point feeder supply connection with across-the-line magnetic type starter with overload protection.
      - ii) HOA switch and green running light for integral circulating pump, circuit breaker switch, 120/24 volt transformer with fused primary and fused secondary protection.
      - iii) High temperature alarm with bell, red light and silence switch.
      - iv) Two pole relays with N/O and N/C contacts for monitoring of the high temperature shutdown alarm by the remote alarm and the Building Control System.
      - v) 10 year tank warranty.
  - b) Preferred: PVI, Industries, LLC
  - c) Disallowed: None

### B. Hot water storage tank

- 1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred: PVI Industries, LLC
  - c) Disallowed: None
- 2. Component Characteristics:
  - a) Required
    - 1) Materials of Construction:
      - i) AquaPlex stainless steel pressure vessel.
      - ii) ASME certified for 150 psig working pressure.
      - iii) Nonferrous fittings
      - iv) Lifting lugs

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- v) Skidded steel base
- vi) Thermowell fitting
- vii) Fiberglass insulation
- viii) Industrial glass thermometer with well
- ix) Steel jacket panel with industrial grade finish
- x) 1" ASME temperature and pressure relief valve.
- xi) 2" drain valve.
- xii) 10 year warranty.

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Gages shall be 3" minimum and placed in a manner that are easily visible from the service area.
  - 2. Frame for support of heat exchanger and associated equipment shall be installed so as to not interfere with the service of the equipment and be structurally sound.
  - 3. Steam traps shall be piped with unions to allow removal and installed in such a manner as to allow ease of removal.
  - 4. Ensure that full tube clearance is available without significant disturbance to adjacent piping or equipment.
- B. Preferred: No preferences
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Heat Exchangers.
- B. Documentation required:
  - 1. Test reports: Testing, Adjusting, and Balancing.
  - 2. Commissioning report.
  - 3. ASME stamp: Steam-containing Heat Exchangers.
- C. Required testing protocols beyond normal Commissioning and TAB protocols:
  - 1. None

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 22 4000 PLUMBING FIXTURES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 22 11 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Provide clean-outs above all urinals, lavatories, upper terminal water closets and sinks. Clean-outs for lavatories and sinks may be located to side of the fixture.
    - b) Provide additional floor drain in restrooms having four (4) or more water closets
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.
- C. Emergency Shower/Eyewash Stations: Temperature Mixing Valves (TMV) shall not be required for emergency shower/eyewash stations if the water temperature with-in the building meets the requirements defined in ANSI/ISEA Z358.1 – tepid water (60deg. to 100 deg. F.). Water temperature test data shall be provided and indicated as part of the contract documents and if required by local jurisdiction, a letter furnished by FPM Facilities will be provided after such test has been verified and documented. A hot and cold water source shall be required with a TMV on emergency shower/eyewash stations outside of buildings, on the roof or wherever the water temperature with-in the building does not meet the requirements of ANSI/ISEA Z358.1.
  - 1. Required:
    - a) See table below.
  - 2. Preferred: See “Product Requirements” below.
  - 3. Disallowed: Pull out, drench hose type eyewash is Non-compliant to ANSI/ISEA Z358.1 and not allowed.

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<b>Emergency Shower/Eyewash Requirements/Features</b>			
<b>Emergency Shower/Eyewash Features</b>	<b>Emergency Shower/Eyewash Location</b>		<b>Remarks</b>
	<b>Labs and Cleanrooms</b>	<b>Mechanical Rooms and Rooftop Mechanical Area</b>	
Local Horn/Strobe	YES	YES	
(2) Dry Contacts Option Kit	YES	YES	(1) Dry Contact for Connection to DPS ; (1) Dry Contact for Local Horn Strobe
E-Power to Horn/Strobe	YES (Conditional - Please see remarks)	YES (Conditional - Please see remarks)	Emergency power (E-power) to Emergency Showers & Eyewashes are not necessarily required. If the intent for the laboratory or building is to have emergency power and be operational, then e-power will be provided.
Contacts for Connection to DPS	YES	YES	Notification to DPS can be made thru the fire alarm (if present in the building). Low voltage wiring from dry contact to fire alarm panel to be done by contractor other than the fire alarm contractor. Fire alarm contractor to land wiring from Emergency Shower & Eyewashes at fire alarm panel
Extra contact for future connection to BAS	NO	NO	
Floor Drains (Renovations & New Construction)	YES	NO	

## USC DESIGN GUIDELINES

### 3. PRODUCT REQUIREMENTS

A. Component Characteristics (**Non-Housing projects**):

1. Required: Provide the following fixtures

Type	Model Number	Color	Additional appurtenances
Water Closet (Non-ADA, Floor Mounted; Only for use where there are structural implications; Requires FPM Facilities approval)	American Standard Madera Flowise 3451.001	White	Sloan Optima 8111.128 Chrome flush valve (battery powered) and Church 9500 Seat
Water Closet (ADA, Floor Mounted Only for use where there are structural implications; Requires FPM Facilities approval)	American Standard Madera Flowise 3461.001	White	Sloan Optima 8111.128 Chrome flush valve (battery powered) and Church 9500 Seat
Water Closet (Non-ADA, Wall Mounted)	American Standard Millennium AFWall 3351.101.	White	Sloan Optima 8111.128 Chrome flush valve (battery powered) and Church 9500 Seat
Water Closet (ADA, Wall Mounted)	American Standard Millennium AFWall 3351.101.	White	Sloan Optima 8111.128 Chrome flush valve (battery powered) and Church 9500 Seat
Urinals	Zurn "The Small Pint" Z5738.205.00	White	Battery operated integral flush valve
Lavatories : wall hung	American Standard Lucerne 0355.012	White	Lavatory Faucet, mixing valve, grid drain, tailpiece, trap assembly, insulation kit and supply stops.

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<b>Type</b>	<b>Model Number</b>	<b>Color</b>	<b>Additional appurtenances</b>
Lavatories : wall hung with soap dispenser	American Standard Lucerne 0355.034	White	Optional soap dispenser 4503.115, Lavatory Faucet, mixing valve, grid drain, tailpiece, trap assembly, insulation kit and supply stops.
Lavatories: Under counter	American Standard Ovalyn 9482.000	White	Lavatory Faucet, mixing valve, grid drain, tailpiece, trap assembly, insulation kit and supply stops.
Faucet for Lavatories With 4" centers (Standard)	American Standard Innsbrook 6053.204	Chrome	Sensor activated faucet (10 Yr. battery powered); Thermostatic mixing valve 605XTMV1070 Faucets shall come factory set on sensor mode in lieu of timed setting.
Remodel/Retrofit Faucet for existing Lavatories with 8" centers or single hole	American Standard Innsbrook 6053.104		Sensor activated faucet (10 Yr. battery powered); Thermostatic mixing valve 605XTMV1070 Faucets shall come factory set on sensor mode in lieu of timed setting. Provide Danco Model # 89344 cover plates where required
Emergency shower/eyewash(in door)	Haws 8356WCC or equivalent by Guardian		Axion MSR Stainless steel eye/face wash # SP65SS, Tempered water mixing valve, Haws 9201H or equivalent by Guardian
Emergency showers/eyewash (outdoor)	Haws 8300-8309, 8309WC or equivalent by Guardian		MSR Stainless steel Showerhead, Tempered water mixing valve, Haws 9201H or equivalent by Guardian

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Type	Model Number	Color	Additional appurtenances
Emergency eyewash	Haws 7655WCC or equivalent by Guardian		Axion MSR Stainless steel eye/face wash # SP65SS, Tempered water blending system Haws TWBS.EWE or equivalent by Guardian
Service Sink (corner/floor)	American Standard Florwell 7741.811		3" trap/strainer and Wire Rim Guard.
Service Sink (wall)	American Standard Lakewell 7692		Trap – American Standard 7798.030
Faucet for Service Sinks	American Standard 8354.112		Wall brace, vacuum breaker

2. Preferred: Coordinate the following fixtures:

Type	Model Number	Color	Additional appurtenances
Kitchen Sink	Elkay, Just		Stainless steel 18 gauge
Garbage Disposal	In-Sink-Erator Evolution		3/4HP
Shower	American Standard,		Pressure balance valve.
Shower (ADA)	American Standard, Powers		Pressure balance valve
Electric Water Cooler	Elkay LZSTL8WSSVP		Stainless Steel 53100 Water Filter
Floor Drain, Floor Sink, Roof, Area and Overflow drains	J.R. Smith, Zurn, Josam		
Hose Bibb	Acorn, Woodford		With non-removable vacuum breaker

3. Disallowed: None

- B. Component Characteristics (**Housing projects**):
1. Required: Provide the following fixtures



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Type	Model Number	Color	Additional appurtenances
Water Closet (Non-ADA):	American Standard Cadet Pro 215CA.104	White	12"rough in and Olsonite, heavy-duty, polypropylene with stainless steel bolts toilet seat
Water Closet (ADA)	American Standard Cadet Pro 215FA.104	White	12"rough in and Olsonite, heavy-duty, polypropylene with stainless steel bolts toilet seat
Kitchen Sink	American Standard 17DB.332283.073	Stainless Steel	
Faucet for Kitchen Sink	American Standard Reliant+ 4205.000.F15.002	Polished Chrome	
Garbage Disposal	In-Sink-Erator Evolution ProCompact		3/4HP
Lavatories	One-piece Dupont Corian, Grade C, with integral sink # 810	White	
Faucet for Lavatories Student Housing Units	American Standard Monterrey # 6114117.002	Polished Chrome	Single Control with pop-up drain, rod & hole, 1.2gpm aerator.
Faucet for Lavatories Student Housing General Areas	American Standard Monterrey # 6114118.002	Polished Chrome	Single Control less pop-up drain, Grid drain 2411015, offset drain assembly 7723018.002, & 1.2gpm aerator.
Bathtub	American Standard Princeton. Left install- 2390.202ICH Right install - 2391.202ICH	White	

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Type	Model Number	Color	Additional appurtenances
Bath/Shower Trim	American Standard Colony T675.508.002, Valve R120SS with integral stops	Polished Chrome	Shower head American Standard Flowise Square Head 1660.811, saves 40% water
Angle stops	Aquaflo E-Z turn ball valve, V-302-A 1/2" FIP x 1/2" OD comp.		
Water Supplies	Aquaflo	Stainless Steel	

2. Preferred: No preference
3. Disallowed: None

#### 4. INSTALLATION REQUIREMENTS:

- A. Required:
  1. Provide Hose Bibb:
    - a) Close vicinity of grease interceptors, sewage and sump pits, if any. Refer to section 22 1100 for additional requirements.
  2. Provide trap primer for trap seal:
    - a) Floor Drains
    - b) Floor sinks
    - c) All hub drains
- B. Preferred: Floor drains or similar traps directly connected to the drainage system and subject to infrequent use shall be protected with a trap seal primer.
- C. Disallowed: None

#### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: None.
- B. Documentation required:
  1. Lead-free fixtures: All fixtures, pipes and plumbing fitting that intended to convey or dispense water for human consumption through drinking or cooking
- C. Required testing protocols: None

**END OF DOCUMENT**

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Type	Model Number	Color	Additional appurtenances
Emergency eyewash	Haws 7655WCC or equivalent by Guardian		Axion MSR Stainless steel eye/face wash # SP65SS, Tempered water blending system Haws TWBS.EWE or equivalent by Guardian
Service Sink (corner/floor)	American Standard Florwell 7741.811		3" trap/strainer and Wire Rim Guard.
Service Sink (wall)	American Standard Lakewell 7692		Trap – American Standard 7798.030
Faucet for Service Sinks	American Standard 8354.112		Wall brace, vacuum breaker

2. Preferred: Coordinate the following fixtures:

Type	Model Number	Color	Additional appurtenances
Kitchen Sink	Elkay, Just		Stainless steel 18 gauge
Garbage Disposal	In-Sink-Erator Evolution		3/4HP
Shower	American Standard,		Pressure balance valve.
Shower (ADA)	American Standard, Powers		Pressure balance valve
Electric Water Cooler	Elkay LZSTL8WSSVP		Stainless Steel 53100 Water Filter
Floor Drain, Floor Sink, Roof, Area and Overflow drains	J.R. Smith, Zurn, Josam		
Hose Bibb	Acorn, Woodford		With non-removable vacuum breaker

3. Disallowed: None

- B. Component Characteristics (**Housing projects**):
1. Required: Provide the following fixtures

## USC DESIGN GUIDELINES

Type	Model Number	Color	Additional appurtenances
Water Closet (Non-ADA):	American Standard Cadet Pro 215CA.104	White	12"rough in and Olsonite, heavy-duty, polypropylene with stainless steel bolts toilet seat
Water Closet (ADA)	American Standard Cadet Pro 215FA.104	White	12"rough in and Olsonite, heavy-duty, polypropylene with stainless steel bolts toilet seat
Kitchen Sink	American Standard 17DB.332283.073	Stainless Steel	
Faucet for Kitchen Sink	American Standard Reliant+ 4205.000.F15.002	Polished Chrome	
Garbage Disposal	In-Sink-Erator Evolution ProCompact		3/4HP
Lavatories	One-piece Dupont Corian, Grade C, with integral sink # 810	White	
Faucet for Lavatories	American Standard Seva # 1480.101.002	Polished Chrome	With pop-up drain.
Bathtub	American Standard Princeton. Left install- 2390.202ICH Right install - 2391.202ICH	White	
Bath/Shower Trim	American Standard Patience T106.508.002, Valve R110SS with integral stops	Polished Chrome	Shower head American Standard with 1.8gpm flow rate
Angle stops	Aquaflo E-Z turn ball valve, V-302-A 1/2" FIPx1/2" OD comp.		

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Type	Model Number	Color	Additional appurtenances
Water Supplies	Aquaflo	Stainless Steel	

2. Preferred: No preference
3. Disallowed: None

#### 4. INSTALLATION REQUIREMENTS:

- A. Required:
  1. Provide Hose Bibb:
    - a) Close vicinity of grease interceptors, sewage and sump pits, if any. Refer to section 22 1100 for additional requirements.
  2. Provide trap primer for trap seal:
    - a) Floor Drains
    - b) Floor sinks
    - c) All hub drains
- B. Preferred: Floor drains or similar traps directly connected to the drainage system and subject to infrequent use shall be protected with a trap seal primer.
- C. Disallowed: None

#### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: None.
- B. Documentation required:
  1. Lead-free fixtures: All fixtures, pipes and plumbing fitting that intended to convey or dispense water for human consumption through drinking or cooking
- C. Required testing protocols: None

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 22 7000 FACILITY NATURAL GAS DISTRIBUTION

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to section 22 00 00, 22 16 00, 22 34 00, and 33 5100.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Standards and Code Requirements
  - 1. Required:
    - a) Submit test reports and inspection certification for all natural gas system installed.
    - b) Submit welder's certification prior to any shop or field fabrication. Welder's certifications shall be current within six (6) months of submission.
    - c) Record actual locations of valves, regulators, etc and prepare valve charts.
    - d) Provide full written description of manufacturer's warranty.
  - 2. Preferred: No Preferences.
  - 3. Disallowed: None
- B. Calculation Requirements
  - 1. Natural Gas sizing table with total developed length indicated.
- C. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS

- A. General Requirements:
  - 1. Required:
    - a) Material Requirements

Service	Size	Location	Material	Joining Method
Low Pressure Gas	All	Underground (Site)	Schedule 40 Black Steel Wrapped.	Welded

## USC DESIGN GUIDELINES

Service	Size	Location	Material	Joining Method
Low Pressure Gas	All	Underground (FPM Facilities Directed)	Polypropylene "Yellow" PE 2406	Socket Fusion
Low Pressure Gas	All	Above Ground	Schedule 40 Black Steel	Screwed
Medium Pressure Gas (5 psi)	All	Above Ground	Schedule 40 Black Steel	Welded
Medium Pressure Gas (5 psi)	All	Underground (Site)	Schedule 40 Black Steel Wrapped	Welded
Medium Pressure Gas (5 psi)	All	Underground (FPM Facilities Directed)	Polypropylene "Yellow" PE 2406	Socket Fusion

2. Preferred: No preferences
3. Disallowed: None.

### B. Gas Piping

#### 1. Required:

- a) Locate gas meters where a straight service run from the street can be made by the gas company and where it is accessible by truck for service and replacement, as central as possible to the major gas loads (e.g. Main boiler rooms) to minimize size and length of main pipe runs.
- b) Meter locations must coordinated with Civil Engineer and approved by the University and the Gas Company.
- c) Medium-pressure gas service shall be approved by the Gas Company.
- d) Provide a gas-schedule for each meter including existing, new and future load in CFH and total developed length from gas meter to furthest gas outlet. Individually indicate gas demand for HVAC, domestic, hot water, kitchen and laboratory needs.
- e) Design private underground gas piping from meter to building and coordinate location elevation with Civil Engineer.

2. Preferred: No preferences
3. Disallowed: Ball valves

## 4. INSTALLATION DESIGN REQUIREMENTS

### A. General

#### 1. Required:

- a) Allowable Gas line locations: Locate gas lines above ground in buildings at least 6 inches above floor, it is allowed to run through attic spaces, within covered walkways and in ventilated crawl spaces.
- b) When installed underground, provide 30" minimum cover embedded in 6" of sand all around.
- c) For transitions between plastic and metal pipe, connect to steel pipe with Central Plastics Company fabricated transition fitting or equivalent as allowed by FPM Engineering.
- d) Provide an accessible shut-off valve for each gas outlet or group of outlets within a room.

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- e) Provide individual check valves for gas outlets or turrets adjacent to air or water outlets, such as laboratory stations.
  - f) Provide a master shut-off valve for labs in a secure area not accessible by students
  - g) Provide an isolation valve for each floor in each building.
  - h) Provide isolation valve at each regulator. Vent pressure regulator to atmosphere if regulator is located within building.
  - i) Provide approved Earthquake Shut-Off Valve for each gas meter.
  - j) Gas valves shall be lubricated plug valves, full port, semi-steel/cast iron/bronze, U.L. Listed, similar to Homestead Figure 601/602.
- 2. Preferred: No preferences
  - 3. Disallowed:
    - a) Avoid lengthy horizontal rooftop mounted piping whenever possible
    - b) Avoid running gas lines through one building to serve another.
    - c) Ball valves are not acceptable for natural gas systems.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification or commissioning:  
Required Items: Code required pressure test.
- B. Documentation required:
  - 1. Pressure test report.
- C. Required testing protocols:
  - 1. Code-required Pressure tests for all systems

**END OF DOCUMENT**



# USC DESIGN GUIDELINES

## 23 0000 MECHANICAL DESIGN REQUIREMENTS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to all product-based sections.
- C. The following table summarizes the types of requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	

- D. Additional Information:
  - 1. Client Goals are stated as follows. All design proposals shall address these concerns in the form of a narrative based on the ASHRAE Guideline 0 and its definition of a Basis of Design document. All alternate proposals that do not explicitly follow this Guideline shall require a comparison analysis between the Guideline Baseline requirement and the proposed scheme for the relevant criteria as agreed with FPM Facilities. Explicit approval shall be obtained from FPM Engineering for experimental designs before commencement.
    - a) Easy to install.
    - b) Easy to operate and maintain.
    - c) Easy to replace.
    - d) Energy efficient.
    - e) Proven reliability.
    - f) Designed upon well established principles.
    - g) Constructed of standard, use-proven materials.
    - h) Acceptable procurement lead time.
    - i) As low in initial cost as practical.
    - j) Low operating cost.
    - k) Low maintenance cost.
    - l) Lowest life cycle cost for highly energy efficient installations that incur a higher initial cost.
    - m) Environmentally friendly.
    - n) Acoustically compatible with occupied spaces. Follow *USC Design Guidelines* for Acoustics and Vibration Requirements, refer to Section 13 48 00.
    - o) Minimize susceptibility to vandalism.
    - p) Minimize degree of disruption of occupants during renovations.
    - q) Understand site constraints and impacts on adjacent buildings and uses.
    - r) Appropriate to stated operating schedules.
  - 2. Available Documentation:
    - a) Utility Master Plan
    - b) Facilities Condition Assessment Reports
    - c) Building Record Drawings

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3. Campus Site Utilities:
  - a) Refer to Section 33 60 00 for campus site utility criteria for hydronic and steam utilities.
  - b) If building is connected to central campus chilled water utility, it shall be assumed that chilled water is not available 24 hours a day / 7 days a week. If any equipment in a space is connected to emergency standby power, then the HVAC equipment serving the space shall also be on emergency power and shall be a DX type system.
  - c) Refer to installation portion of 23 21 13 for Building Utility connection details.
  - d) The campus chilled water loop shall not be utilized to provide hydronic cooling of water-cooled process or lab equipment.
4. Campus Building Management System Connections:
  - a) For design parameters for the building management system, see the independent controls guidelines and coordinate with FPM Engineering.
  - b) Equipment specified to have an independent on-board manufacturer-provided control system shall be connected to campus EMS system for monitoring. Coordinate with FPM Facilities on point mapping and protocol gateway requirements.
5. Airside & Hydronic System Pre-Readings:
  - a) Airflow pre-readings of existing air distribution devices and equipment are required for all projects where existing HVAC systems are planned to be re-used and re-balanced as part of the project scope.
  - b) Pre-readings of existing hydronic distribution devices and equipment are required for all projects where existing hydronic systems are planned to be re-used and re-balanced as part of the project scope.
  - c) Engineer is required to identify in plans and in the single line diagrams where the necessary "pre-readings" of flow, pressures, temperatures, etc. should be taken so that an "as-built" condition is documented prior to any demolition. If an entire retrofit area is served from a single branch line and the flow is maintained within 10% of the current reading, then the measurement reading only needs to take place at the point of disconnection. If the retrofit intends to affect multiple branches served off of a single line, the readings shall be taken for all existing and untouched branches downstream of the first affected branch closest to the source and shall document the flow in the mains at that point. If the retrofit intends to require an increase of more than 10% in the affected mains, then the Engineer shall evaluate the capacity of the entire system back to the point at which the future flow is within 10% of the total available capacity.
6. Retrofit Applications:
  - a) Coordinate with USC project manager to perform a pre-intervention testing, adjusting and balancing exercise to measure flows and pressures for all locations denoted in the Engineer's instructions for pre-reads. At that time, provide sufficient measurement data to map the pressure profile within the system.
  - b) Provide evidence, through calculations, that there is sufficient pressure and flow available to serve the intended design intent of the retrofit.
  - c) Cut all piping branches back to the nearest tap at the branch source and provide shut-off valve and cap at that position in order to avoid a dead leg.
  - d) Cut all ductwork branches back to the branch source. Leave the tap fitting in place and cap the branch within 6" of the main source ductwork.

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- e) When installation is complete, provide testing, adjusting, and balancing to reinstate flows at previous measurement locations as documented in the pre-read and balance the retrofit area as per the requirements of 23 05 93.
  - f) Where a scope of work area is served by terminal units that also serve areas outside of this area, the engineering consultant shall perform the necessary research, to indicate requirements for the balancing of the terminal air unit (and by default all of the distribution connected onto it).
  - g) Where new air balancing requirements or criteria are to be provided, even where no modifications to the location of this distribution, the engineering consultant shall at minimum complete a cursory field observation, in order to assure original air distribution is consistent with available as-built documentation.
  - h) Terminal Units (VAV/CAV boxes, laboratory air valves, etc.) and/or Fan Coil Units serving a space(s) that are part of a renovation/tenant improvement project and which are  $\geq 15$  years of age shall be assessed by the project mechanical engineer of record prior to specifying re-use of said equipment. This assessment shall ensure that the existing equipment's physical condition and performance parameters (i.e., cooling/heating, filtration, and ventilation capacities) meet both the projects thermal comfort criteria and will comply with the building codes which apply to the project. If it is determined that new Terminal Units and/or Fan Coil units are to be provided, the new equipment shall interface with the campus control system.
7. Vibration & Acoustics:
- a) Section 13 4800 is intended to act as a guide where an acoustical consultant or a project specific acoustical criteria does not exist.
  - b) Where conflicts arise between Division 23 and 13 4800, it shall be brought to USC's attention.
8. Building Information Modeling:
- a) The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Refer to individual sections under "Procedural requirements" for which equipment has this BIM requirement.
9. Commissioning:
- a) USC will engage an Independent Consultant to perform the role of a Commissioning Agent. Please refer to the independent Commissioning Guidelines for more information regarding sample Pre-Functional Checklists and Functional Test procedures.
  - b) The Commissioning Agent will review and provide comments on the following design documents: Schematic Design, Design Development, and Construction Documents. The design team shall provide written response and evaluation of the comments.
  - c) During the Design Development Review, the design team shall cooperate with the Commissioning Agent to develop criteria for test protocols to be included in the Construction Documents.
  - d) If items remain unresolved between the Commissioning Agent comments and the design team by the end of the Construction Documents Commissioning Review and Response, the design team shall engage with USC to resolve any remaining disagreements and reach consensus on the final content of the Documents.

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10. Leak Detection:
  - a) Mechanical rooms where hydronic piping is present and where a leak would result in substantial damage to property or operations shall be provided with a leak detection system. Refer to section 3, "Product Requirements" for additional information.

## 2. PROCEDURAL REQUIREMENTS

### A. Standards and Code Requirements:

1. Required:
  - a) The HVAC system shall comply with the current California Code of Regulations, Title 24, the standards of ASHRAE, SMACNA and NFPA, as well as the requirement of the local authorities having jurisdiction.
  - b) Any updates to applicable codes (or appropriate industry standards) not reflected, or somehow violated in the current version of this guideline, shall be brought to the attention of FPM Facilities for clarification and subsequent corrections to the language presented here within.
  - c) If any portions of this guideline are found to conflict with one another, formal clarification shall be requested by FPM Facilities. While request is under consideration, the design team shall assume that the stricter requirement / standard of care should apply.
  - d) Air-moving systems supplying a combined airflow to an enclosed space in excess of 2,000 CFM shall be equipped with an automatic shutoff via smoke detection. The engineer shall consider supply from all systems serving the same space. Refer to section 3.F for smoke detection requirements.
  - e) HVAC replacement projects involving work in mechanical rooms or on rooftops are exempt from LA Building Code accessibility review per Code section 11B-202.4, exception #7. The mechanical engineer of record should ensure the architectural plans for accessibility are not included within plan check submittal sets.
2. Preferred:
  - a) None.
3. Disallowed:
  - a) This guideline is not to be considered as a means or implied approval to violate local and state general building or trade codes.

### B. Design Criteria:

1. Required:
  - a) All interior spaces shall be air conditioned unless specifically excluded in this Guide or in writing by the University.
  - b) Perform a psychrometric analysis of the outdoor, indoor, mixed air and AC equipment leaving air temperatures for selection of air conditioning equipment. Refer to Section 23 8216 for AC equipment supply air temperatures. The following parameters shall be reviewed to ensure the equipment can meet the projects' specific indoor environmental requirements:
    - 1) Current California Energy Commission Title 24 Los Angeles CO data station using the 0.1% criteria.
    - 2) Outdoor data published by ASHRAE for Humidification conditions.

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- 3) Outdoor data published by ASHRAE for Dehumidification conditions.
- c) See special requirements for Cooling Tower wet bulb design criteria in 23 6500.
- d) All rooftop air-cooled equipment shall be specified with an ambient air temperature of 105°F.
- e) A field survey performed by the design team of actual internal heat gains in the field conditions and assessment of current demand is required for existing facility projects such as modernization and equipment replacement. Submittal of an existing condition assessment report for University approval is required as part of the schematic design package.
- f) Provide outside air to each room through the HVAC system in compliance with current California Energy Code and ASHRAE recommendations, selecting the larger of the two when a discrepancy arises.
- g) A DX cooling system shall be available year-round, 24-hour operation, for telephone rooms, data centers, server rooms, elevator equipment rooms, freezer farms (Refer to Section 11 5300 for further requirements), electrical rooms with transformers, and critical equipment rooms. If the equipment within a room is on emergency power, then the DX HVAC system serving that room shall be on emergency power.
- h) For large buildings where many fan coil units are used, provide a filtered fresh air fan equipped with heating and cooling coils designed to provide tempered air to the inlet of the fan coil units.
- i) All cooling coils shall be selected per design criteria found in Section 23 8216.
- j) Design strategy of both fire separations and ductwork distribution shall be coordinated so as to keep the need for Fire Smoke dampers to a minimum.
- k) The engineer of record shall submit an HVAC zoning plan for review and approval by FPM Engineering prior to the issuance of design development drawings.
- l) One Fan Coil Unit (FCU), one Terminal Unit (CAV/VAV box), one Package AC Unit, one Split-System DX Unit, or one Heat Pump may serve a zone with a maximum of 5 interior offices or 3 exterior offices. Interior and exterior spaces shall not be mixed within the same zone.
- m) One dedicated Fan Coil Unit (FCU), one Terminal Unit (CAV/VAV box), one Package AC Unit, one Split-System DX Unit, or one Heat Pump shall be provided to conference rooms, corner offices and large copier rooms.
- n) Provide reheat coils in all terminal units, including those serving only interior zones.
- o) Hallways and corridors shall be served by CAV/VAV zones that also serve adjacent office areas.
- p) Provide, design, dimension, coordinate and install the following items:
  - 1) Support and anchorage of all equipment, valving, piping, ductwork, duct silencers and controls equipment and conduit.
  - 2) Thermal and seismic expansion. Refer to Section 23 0516.
  - 3) Vibration isolation and seismic anchorage.
- q) Allowable mechanical services noise, duct velocity, VAV box selection criteria, air valve selection criteria, equipment vibration isolation and design considerations on placement of equipment and mechanical spaces are to follow the criteria set forth in Section 13 4800 Acoustics and Vibration Requirements.

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- r) Criteria related to allowable use of ceiling return plenums and details on transfer boots are provided in Section 13 4800.
  - s) For areas that have wood-flooring, the engineer-of-record shall determine if there are any room humidity requirements for the wood flooring. If so, provide the necessary humidity control to avoid damaging wood flooring.
  - t) New equipment shall be identified with unique mark/tag numbers within floor plans and equipment schedules.
2. Preferred:
- a) DX systems are acceptable only if chilled water is not available during hours of operation for the affected cooling equipment.
3. Disallowed:
- a) Terminal Units (CAV/VAV boxes) serving both an exterior zone and an interior zone.
  - b) Hallways and corridors shall never be served by a dedicated Terminal Units (CAV/VAV boxes).
- C. Special FPM Engineering Criteria:
1. Required:
- a) Within the plans, indicate the required equipment energy efficiencies clearly in the equipment schedules in a separate column.
  - b) Within the plans, clearly indicate how outside air is provided and how much is provided for each HVAC unit in all modes of operation (normal, economizer cycle, demand control ventilation mode, nighttime pressurization, etc). Provide calculations showing how air is relieved from the building in each mode to balance the fresh outside air make-up with exhaust while maintaining building pressures to ensure compliance with California Building Code door closer settings for accessibility.
  - c) Drawings should include single line riser diagram for all air side and wet side systems as overview of the building.
  - d) The designer shall consult with utility suppliers to take full advantage of incentives for higher energy efficiency such as Savings by Design Program of Southern California Edison and The Gas Company.
  - e) When requested by the University, submit design calculations for equipment and system selection criteria such as life-cycle cost and energy analysis, duct friction and pipe friction loss calculations, fan and pump selection curves, heating and cooling coil selection data, chiller and cooling tower selection data, estimated room noise levels (NC), etc.
  - f) Prior to 100% Design Development, design team shall present screening strategy and address any line of site issues anticipated with proposed location and final anticipated installed height of external equipment.
  - g) Engineer-of-record shall provide a zoning plan including thermostat locations and associated Fan Coil Unit (FCU) and Terminal Unit (CAV/VAV boxes) number for review by FPM Facilities. This plan shall be submitted prior to 50% DD submittal date.
  - h) Plans should clearly identify required equipment service clearance space and associated service path. Indicated equipment service clearances shall be per equipment manufacturers' requirements or code mandated clearance – whichever is more stringent.
  - i) The designer shall allow, within the design, a path of travel which would allow for the future replacement of major equipment by FPM Facilities staff.

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2. Preferred:
  - a) All equipment shall be housed on the roof or in Mechanical Rooms within the building.
- D. Calculation Requirements:
  1. Heating and cooling calculations shall be performed on an industry recognized computer program such as Trace 700, HAP, or Energy Pro that will demonstrate compliance with Title 24. The calculations shall be done for each room and each system.
  2. Life cycle cost calculations shall be performed on an industry-standard program such as Trace 700 or DOE-2. The calculations complete with all input and supporting data shall be submitted for review.
    - a) The life cycle cost shall consider the incremental cost of building enclosure, structure, electrical service and other utilities as well as the HVAC systems.
    - b) Cost estimate shall be made in an industry-recognized format and using manufacturer's cost data or data from a nationally recognized source such as Means.
    - c) Utility costs shall be obtained from the utility providers and shall include historical cost escalation trends.
    - d) Maintenance cost shall include a breakdown of labor and materials for each piece of equipment or system component based on nationally recognized references.
  3. The California Energy Commission's (CEC) Certificate of Compliance for Non-Residential Buildings with the necessary backup forms shall be completed on CEC-approved software using the whole building approach performance basis which integrates the building envelope, mechanical and electrical systems as designed.
  4. Cost/Benefit Analysis. By 100% Design Development, the design teams shall conduct a cost/benefit analysis for all proposed energy conservation measures which are beyond the required systems described in the Design Guidelines. The design team shall demonstrate that the combination of all conservation measures will meet a maximum payback period of 7 years.
- E. Quality Assurance requirements beyond standard 1 year warranty: See specific product sections.

### 3. PRODUCT REQUIREMENTS

- A. Steam System Design Requirements:
  1. Required:
    - a) If central steam is not available for the new building, a central hot water boiler shall be provided within the building for space heating.
    - b) If central steam is not available and the building has steam requirements with the building (lab building, humidification, etc.), a steam boiler shall be installed and a steam to hot water heat exchanger shall be installed for the space heating requirements.
    - c) Any variation from the above must be approved by FPM Engineering.
  2. Preferred: No preferences.
- B. Chilled Water System Design Requirements:
  1. Required:

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- a) If central chilled water is not available for the new building, a water-cooled chilled water system shall be provided within the new building. See 23 6400 and 23 6500 for more details.
  - b) Branch chilled water piping shall be connected to the top of horizontal chilled water mains.
  - c) Any variation from the above must be approved by FPM Engineering.
  - d) New hydronic based HVAC equipment (i.e., fan coil units, air handlers...) installed within mechanical rooms as part of a project with a total construction cost exceeding \$100,000 shall include room leak detection as part of the project. Room leak detectors shall interface with the Honeywell BMS system. A maximum of one leak detector per 500 sq. ft. of floor area may be considered for the initial design. Final quantity and placement of leak detectors shall be coordinated with FPM during design development, based on room and piping layout. Provide room signage indicating presence of a wet floor monitoring system.
2. Preferred: No preferences.
  3. Disallowed:
    - a) Unless specific conditions are identified, air cooled packaged chillers shall not be used for the purpose of building HVAC central chilled water equipment.
    - b) Liquid coolers are not allowed for HVAC heat rejection systems.
    - c) The campus chilled water loop shall not be utilized to provide hydronic cooling of critical process lab equipment (non-HVAC related).
- C. Hot Water System Design Requirements:
1. Required:
    - a) Hot water boilers shall be used on projects where steam requirements are minimal.
    - b) Hot water boilers and steam-to-water heat exchangers shall be provided with redundancy when used. There shall be a minimum of 2 devices and designed so that if one device fails, the other can maintain 70% of total peak capacity.
    - c) Boiler equipment layout shall clearly identify tube bundle pull area and shall direct the contractor to maintain this area clear of obstructions.
    - d) Branch heating hot water piping shall be connected to the top of horizontal heating hot water mains.
    - e) New hydronic based HVAC equipment (i.e., fan coil units, air handlers...) installed within mechanical rooms as part of a project with a total construction cost exceeding \$100,000 shall include room leak detection as part of the project. Room leak detectors shall interface with the Honeywell BMS system. A maximum of one leak detector per 500 sq. ft. of floor area may be considered for the initial design. Final quantity and placement of leak detectors shall be coordinated with FPM during design development, based on room and piping layout. Provide room signage indicating presence of a wet floor monitoring system.
  2. Preferred:
    - a) Primary/secondary operation shall be used when modular boilers are installed.
    - b) HHW systems shall be primary secondary pumping with 3-way valve to control set-point and reset.



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- c) Pipes shall be arranged so tubes can be accessed as primary/return common headers.

### D. Hydronic Pumped System Requirements:

- 1. Required:
  - a) All distribution pumps shall be selected and sized based on the following criteria and redundancy:

Motor Size	Pump Sizing	Comments
< 10 Hp	Each at 100% of proposed load	Minimum of two pumps for redundancy
≥ 10 Hp	Select pump sizes to equal no less than 140% total of required capacity	Minimum of two pumps for redundancy

- 1) Any deviation shall be submitted for review by FPM Engineering along with justification for suggesting a different strategy in terms of sizing to match loads and meeting the intent of requirement to provide redundancy.
- b) Redundant pumps(s) are intended to function as stand-by, yet shall be operated on a lead/lag sequence that allows for even sharing of overall run time hours.
- c) Any deviation from the above must be submitted for approval.
- 2. Preferred: No Preferences.
- 3. Disallowed: None

### E. Air Handling System Design Requirements:

- 1. Required:
  - a) Only Custom Air Handling Units per 23 7323 shall be allowed. Any variation must be approved by FPM Engineering.
  - b) Provide air handling units with preheat coils for 100% OSA systems unless otherwise specified by FPM Engineering.
  - c) All roof mounted air handling units shall be installed on either an elevated curb, concrete pad, or structure. All floor mounted air handling units shall be installed on a minimum 6" high concrete curb. Refer to section 23 7323 for more details.
  - d) For concrete pad applications, coordinate required air handling unit equipment pad edge distance with structural engineer to minimize unnecessary pad surface area, where ponding of water may occur. Refer to section 23 7323 for more details.
- 2. Preferred: No preferences.
- 3. Disallowed:
  - a) Modular and off-the-shelf semi-custom Air Handling Units are not allowed.
  - b) Packaged DX Outdoor Air Handlers (whether custom-built or not) are not allowed.
  - c) Water-source heat pumps are not allowed.
  - d) Ceiling Plenum Systems: Other than approved return air plenums for centralized systems that are collected on a common floor, ceiling plenums are not allowed for distribution of supply, outside, or exhaust air, to or from respective HVAC fan systems.

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- e) Architectural/General Construction Wall or Ceiling Plenum systems are not allowed as sole means for distributing air to or from any type of HVAC fan systems - air shall not come into direct contact with architectural / structural enclosures.
- F. Smoke Detection Design Requirements:
- 1. Required:
    - a) The engineer shall coordinate with FPM Facilities to determine if a total coverage smoke detection system (in all areas served by the subject HVAC system) is present in the building or within the confines of the project. Engineer of Record to determine how the smoke detection devices are to be specified for the project per the following scenarios, listed in preferential order. Refer to Section 28 3100 for additional information.
      - 1) Scenario #1: If a total coverage smoke detection system is present, it shall be used to trigger air moving equipment (AHU, FCU, AC Units, Fans, etc.) hard-wired shut down and the closure of fire smoke dampers in response to a smoke alarm. Coordinate with the Fire Alarm Designer as necessary to achieve this goal.
      - 2) Scenario #2: If a total coverage smoke detection system is not present, all air moving equipment (AHU, FCU, AC Units, Fans, etc.) shall be equipped with factory installed smoke detection devices. Externally mounted “on unit” smoke detectors shall be used if fan (not including damper) shut-off is to be achieved. Internally mounted “in unit” smoke detectors shall only be allowed if fan AND damper(s) shut-off is to be achieved.
      - 3) Scenario #3: If a total coverage smoke detection system is not present and factory furnished smoke detectors within air moving equipment is not possible, externally mounted “on ductwork” smoke detectors shall be used if fan (no damper) shut-off is to be achieved. Internally mounted “in ductwork” smoke detectors shall only be allowed by FPM Facilities if fan AND damper shut-off is to be achieved.
    - b) Externally Mounted (“on unit” or “on ductwork”) Smoke Detector:
      - 1) Indoor Application: Notifier DNR(A) InnovairFlex intelligent non-relay photoelectric type or equal. Provide with RA100Z(A) remote annunciator alarm LED.
      - 2) Outdoor Application: Notifier DNRW InnovairFlex intelligent non-relay photoelectric type or equal.
    - c) Internally Mounted (“in unit” or “in ductwork”) Smoke Detector:
      - 1) Notifier FSP-851(A) intelligent plug-in photoelectric type or equal. Provide with RA100Z(A) remote annunciator alarm LED.
- G. Laboratory Exhaust System Design Requirements:
- 1. Refer to Division 11 for laboratory exhaust systems and fume hoods.
  - 2. Use internal heat gain criteria provided in Section 11 53 00 for laboratory systems.
- H. Critical Equipment Laboratories / Freezer Farms / Cold Rooms Design Requirements:
- 1. Refer to Section 11 5300 Laboratory Planning for standby power for critical equipment in laboratories, freezer farms, and cold rooms.

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2. Engineer to coordinate standby power requirements, system redundancy requirements, DDC interface, and notification alarms for Mechanical/HVAC equipment that supports these spaces.
  3. Engineer to review USC Emergency Scenario Flow Chart with project stakeholders to coordinate design to protect all critical equipment (freezers, freezer compressors, cold rooms, Mechanical/HVAC equipment, etc.).
- I. Leak Detection at Mechanical Rooms:
1. Water leak detection shall be provided at all new mechanical rooms where hydronic utilities are present.
  2. Water leak detection shall also be provided within existing mechanical rooms equipped with hydronic systems, if construction work is being performed within the mechanical room and total project construction costs exceed \$100,000.

#### 4. INSTALLATION DESIGN REQUIREMENTS

- A. Required:
1. Provide Utility connections as noted in Section 23 2113. Any connections to University utilities must have FPM Engineering approval.
  2. Ensure maintenance and accessibility provisions for servicing and replacement.
  3. Identify, within plans, necessary working area needed for equipment service and repair.
  4. Where HVAC equipment is roof mounted or require roof openings, verify that all structural provisions are made to assure adequate capacity for load bearing and diaphragm capacity and noise and vibration attenuations. Refer to Section 13 48 00 for attenuation requirements.
  5. Where HVAC equipment is located at grade level and/or in an open public accessible area, a fence/gate/etc. shall be provided for security and/or visibility purposes. Coordinate requirements with FPM Engineering. Refer to Section 01 8316.
  6. There must be permanent access to the roof if any equipment needing service is mounted to the roof. This access path shall allow for removal of major / large equipment components through the building to avoid the need for specialized rigging equipment whenever major service is required.
  7. An additional set of permanent filters shall be turned over to FPM Facilities, where an existing centralized or de-centralized HVAC fan system; is (1) to be reused as part of a space remodel, or (2) itself to be retrofitted under any circumstances.
  8. Do not utilize pitch pockets at fixed, roof mounted, pipe and ductwork supports.
  9. Provide a minimum of 8" clear space between finished roof surface and underside of rooftop mounted piping and ductwork, when utilizing fixed pipe supports, to allow future re-roof work.
  10. For systems incorporating vibration isolation, manufacturer to provide written confirmation that the vibration isolation system has been adjusted at aligned at the close of project.
  11. Automatic timers are required for lighting at air handler interiors.
  12. When relocating or adding rooftop HVAC equipment or where HVAC equipment is located at grade level. A/E to identify and coordinate potential sight line issues with University Architect for review and approval.

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B. Preferred: No Preferences.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items:
1. See individual product specification sections for which items are to be commissioned or tested.
- B. Documentation Required:
1. See individual product specification sections for specific documentation.
  2. Commissioning reports: All HVAC equipment using or converting energy from any source (i.e. electricity, gas, campus utilities) shall fall under the scope of the Commissioning process and be subject to the protocols listed in the independent Commissioning guidelines.
  3. Operations and Maintenance Manuals: shall be provided as required by the independent Close-out Guidelines
  4. Controls information: shall be provided as required by the independent controls Specifications.
- C. Required Testing Protocols: None.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 0513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 05 14.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Special consideration to be given to the selection and placement of fan motors that serve lab exhaust systems and come in contact with effluents being removed.
  - 2. Preferred: No preferences
  - 3. Disallowed: Fan Motors shall not be selected in the service factor.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Motors provided integral to a piece of equipment shall be covered by the BIM object of that piece of equipment. Otherwise, loose motors shall have a BIM family provided within the BIM model.

### 3. PRODUCT REQUIREMENTS

- A. Motors:
  - 1. Manufacturers:
    - a) Required: No Requirements
    - b) Preferred:
      - 1) Lincoln
      - 2) Baldor-Reliance-ABB
      - 3) US Motors
      - 4) GE
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:

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Motor Size	Premium Efficiency	Inverter Duty Rated	VFD Required (see also 23 05 14)
<3 HP	-	If controlled by VFD	For variable flow application only
3 – 5 HP	X	If controlled by VFD	For variable flow application only
>5 HP – 10 HP	X	X	For variable flow application only
>10 HP	X	X	In all applications

- 1) Motors shall be properly rated and enclosed, based on their proposed location in the following categories:

Location	Motor Type
Indoors	ODP (1) (2)
Indirectly Exposed Outdoors	TEFC
Completely Exposed to Outdoors	TEFC
(1) Where motor is in mechanical room or wet or saturated airstream, use TEFC. (2) Where flammable content in airstreams is anticipated, use explosion proof motors.	

- b) Preferred: No preferences  
 c) Disallowed: None

#### 4. INSTALLATION REQUIREMENTS

- A. Required: None  
 B. Preferred: None  
 C. Disallowed: None

#### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
 Required Items: All motors with greater than 100V.
- B. Documentation required:
1. Test, Adjusting & Balancing Reports.
  2. Commissioning report.
  3. UL listing.
  4. NEMA Rating of Enclosure.
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 0514 VARIABLE-FREQUENCY MOTOR CONTROLLERS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 05 13.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) See Section 23 05 13 for motor sizes requiring VFD's.
    - b) VFD shall be UL listed for a short circuit current rating of 100,000 amps and tested to UL508C.
    - c) The VFD shall be in compliance with the seismic requirements of California Building Code.
    - d) Review VFD configuration with FPM Facilities.
    - e) Multiple Fan (fan array) Applications:
      - 1) Two (2) VFDs shall be provided. System shall be configured to have one (1) VFD to provide power/control to all motors. A lead-lag VFD controller shall be provided to alternate between the two (2) VFDs.
      - 2) Means of disconnect shall be provided to facilitate removal/service of individual motors.
      - 3) Bypass is not required under this application.
    - f) Single Fan Applications:
      - 1) One (1) VFD shall be provided.
      - 2) Bypass is required under this application.
  - 2. Preferred: No preferences
  - 3. Disallowed: VFD shall not be selected to operate above 60Hz.

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- B. Quality Assurance requirements beyond standard 1 year warranty: 3 years
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. VFDs provided integral to a piece of equipment shall be covered by the BIM object of that piece of equipment. Otherwise, loose VFD shall have a BIM family provided within the BIM model.

### 3. PRODUCT REQUIREMENTS

- A. Variable Frequency Controller:
  - 1. Manufacturers:
    - a) Required:
      - 1) All VFDs serving HVAC equipment as part of a single project shall be provided by a single manufacturer.
    - b) Preferred:
      - 1) Danfoss
      - 2) ABB
      - 3) Approved equal
    - c) Disallowed:
      - 1) Relabeled VFDs.
  - 2. Component Characteristics:
    - a) Required:
      - 1) Variable frequency drive shall be specified for the correct, NEMA rated enclosure for proposed location as follows:

Location	NEMA Enclosure
Indoors – Rooms without liquid filled piping.	NEMA 1
Indoors – Rooms with piping that contains water, steam, condensate or other liquids.	NEMA 3R
Exposed Outdoors (directly or indirectly)	NEMA 3R

- 2) If VFD bypass is required per the procedural requirements identified above, the VFD bypass shall be a 3-contactor type (in order to bypass drive, control in hand, or automatic) for mechanical systems in which complete equipment redundancy is not provided. The Bypass shall include an external safety interlock that will disable motor operation in either bypass or VFD when open.
- 3) All power and low voltage terminations into and distribution out of VFD shall be through the bottom of drive cabinet through factory provided knock-outs.
- 4) See standard control diagrams (found outside of this guideline) for confirmation of VFD monitoring and control points, which shall be hard wired and made available for interface with the local building automation or campus Energy Management systems. Respective internal modules and circuitry necessary to allow for these items to be hard-wired shall be specified accordingly.
- 5) The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus. VFD's with saturating (non-



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linear) DC link reactors shall require an additional 3% AC line reactor. VFDs which do not include an integral 5% DC link impedance shall include 5% AC line reactors in the operations enclosure.

- 6) The VFD shall contain integral EMI filters.
  - 7) The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 seconds while starting. The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. Breakaway torque of 160% shall be available.
  - 8) The VFD shall include current sensors on all 3 output phases.
  - 9) The VFD shall continue to operate with reduced output without faulting with input voltage as low as 70% of the nominal voltage and shall provide full rated output for input voltages of 90% of nominal.
  - 10) The VFD shall have a minimum of Class 20 I<sup>2</sup>t motor overload protection, which shall automatically compensate for changes in motor speed.
  - 11) All VFDs shall have the same interchangeable customer interface keypad to allow a single programmable keypad to download information to multiple VFDs during startup procedures.
  - 12) The VFD shall accept up to 3 feedback signals, each with independent scaling.
  - 13) The VFD shall be compatible with LonTalk, BacNet, or Modbus protocols, and provided with the appropriate hardware to communicate operating parameters via the agreed upon protocol. Coordinate exact communications controller card required with the controls contractor.
  - 14) The VFD shall (at minimum) be provided with the necessary hardware to allow for the hardwiring of the following operating parameters; (1) Start / Stop, (2) Status, (3) Speed Output
  - 15) Vertical or horizontal configuration of VFD and its associated by-pass (where applicable), shall be coordinated and specified accordingly, based on space available for mounting and code required clearances.
  - 16) NEMA 3R enclosures shall be provided with auxiliary display mounted on enclosure door to allow for external viewing of VFD conditions.
- b) Preferred: No preferences  
c) Disallowed: None

#### 4. INSTALLATION REQUIREMENTS

##### A. Required:

1. For VFD's mounted remotely beyond 15 feet from unit and out of direct line of sight from equipment, provide auxiliary disconnect on or adjacent to equipment and necessary contacts to de-energize drive. VFD may not be mounted more than 30 feet from unit.

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2. Maintain code required clearances in front of VFD. If discrepancy in clearance arises that is not flagged by City inspectors, FPM Facilities shall have final approval discretion.
  3. VFD shall be installed so that code related clearance area is maintained. Clearance area may overlap other equipment clearances as long as the largest clearance area between the overlapping equipment is maintained.
  4. VFD shall be installed so that there is a level finished floor surface (pad) or catwalk throughout width of drive and full code required clearance in front of drive.
  5. Permanent ladder and walking platform for maintenance access shall be provided for VFD's mounted on equipment where the center of drive cabinet is located at or above 72" AFF.
  6. VFD start-up shall be completed by manufacturer trained and certified representatives.
  7. Input and output wiring of drive must be in separate conduits.
  8. The VFD supplier with the electrical single line diagram shall perform an analysis to demonstrate that the supplied equipment will meet the IEEE 519 requirements using the Point of Common Coupling (PCC) shall be the building side of the utility company transformer.
  9. Where fire alarm system exists, and is capable of supporting the additional devices, any new VFDs provided for supply and return fan systems shall be tied in accordingly. Fire alarm contractor shall coordinate final termination locations with either the VFD installation contractor or the certified start-up vendor, in order to integrate these systems into the fire alarm system for appropriate shut down.
- B. Preferred:
1. It is preferred that VFD's for fans within air handling units shall be mounted externally on unit cabinet. Coordinate with owner for appropriate permanent storage location for O&M manual.
- C. Disallowed:
1. O&M manual shall not be left at bottom of drive cabinet or adjacent to heater.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: All Variable frequency drives covered under this section.
- B. Documentation required:
1. Test, Adjusting & Balancing Reports.
  2. Commissioning report.
  3. UL listing.
  4. NEMA Rating of Enclosure.
  5. Start-up report from certified representative
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 0516 EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 00 00, 23 21 13 and Section 23 22 13.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Expansion loops shall be provided for chilled water, heating hot water, steam and steam condensate piping systems, exceeding 100'-0" in horizontal length and as appropriate to control expansion.
    - b) Determine system's forces and displacements associated with expansion, then design and provide expansion compensation devices, equipment and anchors. Provide for review by FPM Engineering calculations of anticipated expansion and proposed system for controlling expansion including structural calculations for all anchors. This shall be submitted by 50% Construction Documents phase.
    - c) Any proposed pre-fabricated expansion loop systems shall be submitted to FPM Engineering for review.
    - d) Engineering documents shall show expansion loops on plans, provide details regarding size, configuration anchors, guides and means of installation.
  - 2. Preferred: No preferences
- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Expansion joints, expansion loops and expansion fittings shall have a BIM family provided within the BIM model.

### 3. PRODUCT REQUIREMENTS

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- A. Expansion Joints:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: No preferences
  - 2. Component Characteristics:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Expansion loops shall consist of 90° elbows connected by straight length of pipe to form a “U” or “Z”.

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Provide mineral wool fiber at underground 90° elbows intended to act as an expansion control system.
  - 2. Refer to Section 23 00 00 for Contractor delegated design responsibilities for expansion fittings and support.
- B. Preferred: No preferences

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: None.
- B. Documentation required: None
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 0519 METERS AND GAGES FOR HVAC PIPING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13 and independent control guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Pressure and temperature gages shall be selected so that the high limit of range does not exceed a factor of 1.5x the standard operating point for that particular system. Gages shall be selected so system operating pressure is found within the middle 1/3 of overall range.
    - b) See Installation Requirements for required locations.
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None required

### 3. PRODUCT REQUIREMENTS

- A. Gages:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: No preferences
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide the following materials and components for gages:

Gage Type	Application	Materials	Comments
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Gage Type	Application	Materials	Comments
Pressure	Low Temperatures	Construction: Metal Case Window: Glass Liquid: Silicone Oil	Provide pressure snubbers and gage valves.  Note: Select gauge where system operating range lies in middle 1/3 of range for best accuracy.
	Ambient Temperatures	Construction: Metal Case Window: Glass Liquid: Glycerin	
	High Temperatures (HHW, steam, etc.)	Construction: Metal Case Window: Glass Liquid: Sodium-Potassium Eutectic	
Temperature		Construction: Metal Case: Liquid: Mercury Free Window: Glass	Provide coil siphons and gage valves.

- b) Preferred: No preferences
- c) Disallowed: None

### B. Flow Meters:

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) GE
    - 2) Controlatron
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Flow meters shall be ultrasonic, single channel type. Refer to independent controls guidelines for more details.
  - b) Preferred: No preferences
  - c) Disallowed: None

## 4. INSTALLATION REQUIREMENTS

### A. Required:

1. Provide the following ports for purposes of temperature and pressure sensing:

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- a) Pressure and temperature gages shall be provided at building point of entry for hydronic utilities in order to measure conditions entering and leaving the building as a whole.
- b) Temperature gages shall be provided at major air handling unit sections so as to validate mixed air and discharge air temperatures, upstream and downstream of coil respectively.
- c) Provide P/T test plugs at inlet and outlet of each individual coil connection when coils are stacked to make-up overall coil face area in order to verify pressure and temperature drops across each individual coil.

Device Type	Required Locations	Comments
Temperature Gages	<ol style="list-style-type: none"> <li>1. On supply and return at air handling unit coil sections</li> <li>2. Adjacent to inlet and outlet of hydronic source equipment providing a (e.g. chiller, boiler, cooling tower)</li> <li>3. Adjacent to building point of entry of all central hydronic utilities</li> <li>4. Air handling unit mixed air, coil incoming, coil leaving and unit discharge sections</li> </ol>	<p>Installation details and specifications should reflect these requirements, when applicable.</p> <p>Provide appropriate tap offs and gage valves.</p>
Pressure Gages	<ol style="list-style-type: none"> <li>1. Air handling unit mixed air, coil incoming, coil leaving and unit discharge sections</li> <li>2. Hydronic equipment inlet and outlet where pressure drop will be experienced</li> <li>3. Adjacent to inlet and outlet of major hydronic source equipment (e.g. chiller, boiler, cooling tower)</li> <li>4. Adjacent to building point of entry of all central hydronic utilities</li> </ol>	<p>Installation details and specifications all reflect these requirements.</p> <p>Single compound gage shall measure static and differential pressure.</p>
P/T Test Plug	<ol style="list-style-type: none"> <li>1. Inlet and outlet of all coil connection points including all sub-branches serving stacked coils</li> <li>2. Adjacent to pressure and temperature gages</li> <li>3. Adjacent to pressure</li> </ol>	<p>Installation details and specifications shall reflect these requirements.</p> <p>Install directly adjacent to manufacturer provided inlet and outlets of each coil connections.</p>

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Device Type	Required Locations	Comments
	and temperature control sensor locations	
Flow Meter	<ol style="list-style-type: none"> <li>1. At building point of entry of all central hydronic utilities.</li> <li>2. At hydronic source plants (e.g. boilers, chillers, cooling towers)</li> <li>3. Sub-metering locations as directed by USC.</li> </ol>	Locate so that readings can be used for both control and monitoring.

2. Install gages to be serviced without impacting the operation of adjacent or associated equipment.
3. Pressure gages or test ports for reading differential shall be located at same elevation. This also applies to where compound gages are anticipated.
4. Gages shall be mounted to be accessible and easily read by maintenance personnel. This means that it shall be within 8' of the floor or within a 24" radius of an elevated access location. An elevated access location is defined as those points accessible using a ladder but no more than 3' above the top rung of the ladder, where acceptable ladder lengths include: 6' A-frame, 8' A-frame and extension ladders up to 20' long. Where necessary, extensions are to be provided in high ceilings or congested areas to meet these requirements or piping shall be routed to facilitate this accessibility.

B. Preferred: No preferences

C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: None.
- B. Documentation required: None
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**



# USC DESIGN GUIDELINES

## 23 0523 GENERAL DUTY VALVES FOR HVAC PIPING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13, Section 23 21 16, Section 23 22 13, Section 23 05 53 and Section 23 07 19.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

- D. Additional Information: Building incoming hydronic utilities shut-off valves will be provided by campus central utility.

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Shut-off valves shall be provided as noted in the installation section.
    - b) Automated and manual means of building isolation shall be provided. A single set of valves can be provided and this requirement can be consolidated with provisions of mechanical override.
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS

- A. Above Ground Manual Isolation Valves:
  - 1. Manufacturers (as applicable by valve type):
    - a) Required:
      - 1) For a single project, a single manufacturer shall be provided for all like service and valve types.
    - b) Preferred:
      - 1) Nibco
      - 2) Crane
      - 3) Grinnell
      - 4) Apollo
      - 5) Watts

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2. Component Characteristics:

a) Required:

- 1) Provide the following materials and joints for the following valves:

Service	Valve Type	Size	Material	Joining Method
High Pressure Steam (HPS) (1)	Gate/Globe	≤2 ½"	Bronze	Screwed
		≥3"	Cast Iron	Flanged/Lug
Steam Condensate (CR) (1)				
Low Pressure Steam (LPS) (1)	Gate	≤2"	Bronze	Screwed
		≥2 ½"	Steel	Flanged/Lug
Steam Condensate (CR) (1)	Globe	≤2"	Bronze	Screwed
Chilled Water (CHW)	Ball	≤2"	Bronze	Threaded
Heating Hot Water (HHW)	Butterfly	≥2 ½"	Steel	Flanged/Lug
Condenser Water (CDW)				
<i>(1) Spiral Wound Gaskets (rated for service temperatures) shall be used in steam &amp; condensate applications.</i>				

b) Preferred: No preferences

c) Disallowed: None

B. Underground Direct-Buried Manual Isolation Valves (CHW & HHW Only):

1. Manufacturers:

a) Required:

- 1) Henry Pratt – Groundhog Buried Service Butterfly Valves
- 2) Mueller – Lineseal III Butterfly Valves
- 3) For a single project, a single manufacturer shall be provided for all like service and valve types.

b) Preferred: No preferences

2. Component Characteristics:

a) Required:

- 1) Sizes: 4" – 20"
- 2) Body Style: Cast Iron ASTM A-126 Class B, Flanged Ends
- 3) Pressure Class: 150B per AWWA Standard C504
- 4) Shaft: One Piece, Type 304 Stainless Steel ASTM A-276
- 5) Bearings: Corrosion Resistant, Self-Lubricating
- 6) Actuator: Grease Packed, Moisture Intrusion Resistant
- 7) Accessories: Valve Position Indicator with adapter, 2" square AWWA nut and extension stems.

b) Preferred: No preferences

3. Field Installation Requirements:

a) Required:

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- 1) Application of bituminous coating on bolts and nuts at valve flange connections to flange connections of service piping.
- 2) Inspection of valve factory epoxy coating for damage. Application of bituminous coating over damaged areas.

C. Automated/Control Valves:

1. Manufacturers:

a) Required:

- 1) For a single project, a single manufacturer shall be provided for all like service and valve types.

b) Preferred:

- 1) Honeywell
- 2) Belimo

2. Component Characteristics:

a) Required:

- 1) Actuator shall be provided with appropriate enclosure for outdoor weather-proofing, sun exposure, or extreme environments (NEMA 3R, NEMA 4, etc.).

- 2) Refer to independent controls guideline.

b) Preferred: No preferences

### 4. INSTALLATION REQUIREMENTS

A. Required:

1. Provide devices at a minimum at following locations:

Device Type	Required Locations	Valve Type			Comments
		System	Size	Type	
Shut Off Valves	1. Supply and return at each piece of equipment 2. At each floor level branch from risers 3. At the base of vertical risers. 4. At each lab module.	Steam & Condensate	All	Gate	(1)
		Hydronic	≤ 2"	Ball	
			> 2"	Butterfly	
Automated Control Valves	Refer to Section 0901 – BAS Basic Materials	-	-	-	

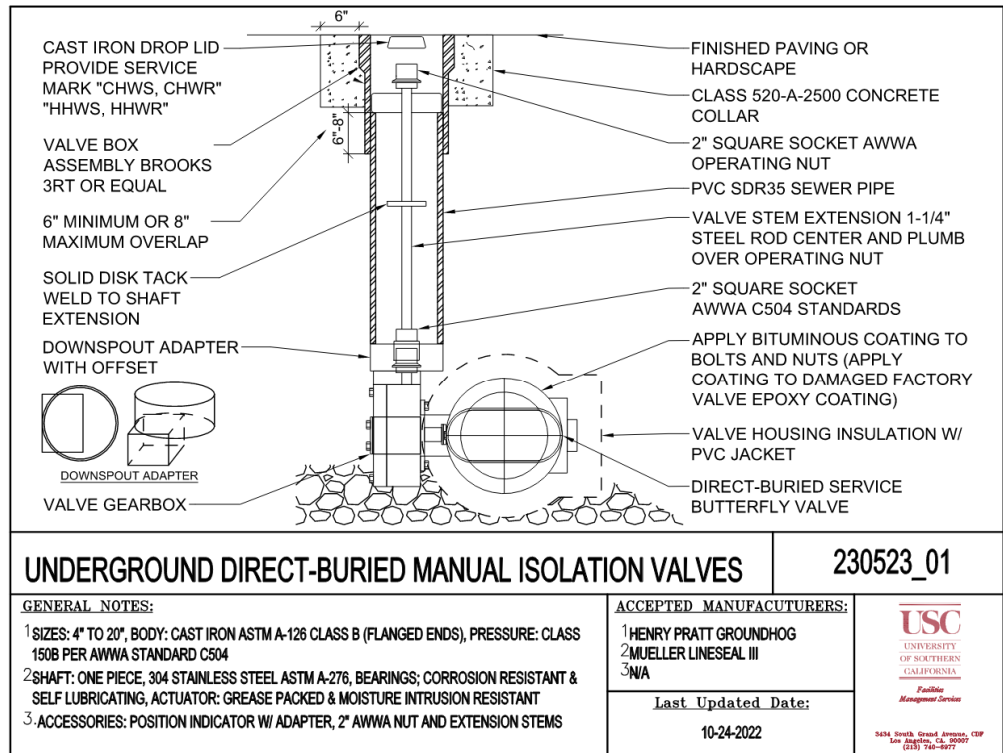
*(1) Spiral Wound Gaskets (rated for service temperatures) shall be used in steam & condensate applications.*

2. Install valves to be readily accessible by maintenance personnel with appropriate means for exercising and removing these valves. This means that it shall be within 8' of the floor or within a 24" radius of an elevated access location. An elevated access location is defined as those points accessible using a ladder but no more than 3' above the top rung of the ladder, where acceptable ladder lengths include: 6' A-frame, 8' A-frame and extension ladders up to 20' long. Where necessary, extensions are to be provided in high ceilings or congested

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areas to meet these requirements or piping shall be routed to facilitate this accessibility.

3. Provide chain operators for equipment room valves 4" and larger located over 78" above finished floor.
4. If manual air vents are provided at high points of underground hydronic pipe distribution, provide proper extensions to grade and valve covers.
5. Refer to the following detail for underground direct-buried manual isolation valves:



- B. Preferred: No preferences
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Control valves as part of commissioning process.
- B. Documentation required:
  1. Commissioning report: Control valves only.
- C. Required testing protocols beyond normal Commissioning and TAB protocols:
  1. Normal Hydronic System Pressure Testing per 23 21 13.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 0553 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13, 23 21 16, 23 22 13, 23 22 16, 23 33 00 and 23 36 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Numbering of equipment within an existing building shall be coordinated and confirmed with FPM Engineering.
    - b) Final equipment designation/numbering shall be in accordance with next available equipment tag sequence, as dictated by USC Computerized Maintenance & Management System and with standard established for that building.
    - c) During 50% DD design, comprehensive specification denoting equipment identification shall be submitted to FPM Engineering for approval prior to integration into the Engineering Documents.
    - d) During construction, the Identification submittal must be reviewed and approved by FPM Facilities.
    - e) Provide submittals for all systems captured under this section to FPM Engineering for review and approval.
  - 2. Preferred:
    - a) Install metal equipment labels for any equipment having moving parts and requiring maintenance or part of central building systems. Exceptions can be made to use plastic equipment labels for items such as TAU's.
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None required

### 3. PRODUCT REQUIREMENTS

- A. Metal Equipment Labels:
  - 1. Manufacturers:

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- a) Required: No requirements
  - b) Preferred:
    - 1) Craftmark Identification Systems
    - 2) Seton Identification Products
    - 3) MSI Marking Services, Inc.
  - c) Disallowed: None
2. Component Characteristics:
- a) Required:
    - 1) Material and Thickness: Brass or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness.
    - 2) Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
    - 3) Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
    - 4) Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and with substrate.
    - 5) Nameplates shall bear notations corresponding to notations on operating instructions and Drawings.
  - b) Preferred: No preferences
  - c) Disallowed: None
- B. Plastic Equipment Labels:
1. Manufacturers:
- a) Required: No requirements
  - b) Preferred:
    - 1) Craftmark Identification Systems
    - 2) Seton Identification Products
    - 3) MSI Marking Services, Inc.
  - c) Disallowed: None
2. Component Characteristics:
- a) Required:
    - 1) Material and Thickness: Three layer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
    - 2) Letter Color: White
    - 3) Background Color: Black
    - 4) Maximum Temperature: Able to withstand temperatures up to 160 deg F.
    - 5) Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
    - 6) Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
    - 7) Fasteners: Stainless-steel rivets or contact-type permanent adhesive, compatible with label and with substrate.

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- 8) Nameplates shall bear notations corresponding to notations on operating instructions and Drawings.
- 9) Consideration shall be given to the appropriate product selection, where equipment or piping will reside in wetted indoor environments.
- b) Preferred: No preferences
- c) Disallowed: None

### C. Pipe Labels:

#### 1. Manufacturers:

- a) Required: No requirements
- b) Preferred:
  - 1) Craftmark Identification Systems
  - 2) Seton Identification Products
  - 3) MSI Marking Services, Inc.
  - 4) Setmark
- c) Disallowed: None

#### 2. Component Characteristics:

- a) Required:
  - 1) Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger pipe sizes may have maximum sheet size with separate fastener.
  - 2) Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing. Each marker shall show accepted color-coded background, proper color of legend in relation to background color, accepted legend letter size, accepted marker length.
- b) Preferred:
  - 1) Confirm latest color standard with the University prior to submittal for approval.
  - 2) Color Coding:

HVAC Piping	Pipe Labels		Pipe Cover/Color Scheme	
	Background Color	Lettering Color	Insulation Jacket Type	Paint
Chilled Water CHW	Green	White	PVC, Dark Blue *	
Heating Hot Water HHW	Yellow	Black	PVC, Orange *	
Steam, Clean Steam, Condensate	Orange	Black	PVC, Orange *	
Condenser Water CW	Green	White		Dark Green
Cold Condensate Drain & Overflow Drain Piping	Green	White		
Temperature Control Air	Green	Black		

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HVAC Piping	Pipe Labels		Pipe Cover/Color Scheme	
	Background Color	Lettering Color	Insulation Jacket Type	Paint
Vent & Safety Relief Vent Piping	Yellow	Black		Yellow
Compressed Air (where provided under HVAC scope)	Yellow	Black		
Chemical Feed Supply & Return	Yellow	Black		
Refrigerant Liquid Line & Refrigerant Suction Line	Yellow	Black		
* Refer to Section 23 0719 for pipe insulation and jacket type schemes. Note that colored PVC is not to be used for outdoor/exposed applications.				

c) Disallowed: None

### D. Duct Labels:

#### 1. Manufacturers:

- a) Required: No requirements
- b) Preferred:
  - 1) Craftmark Identification Systems
  - 2) Seton Identification Products
  - 3) MSI Marking Services, Inc.
  - 4) Setmark
- c) Disallowed: None

#### 2. Component Characteristics:

- a) Required:
  - 1) Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing. Each marker shall show accepted color-coded background, proper color of legend in relation to background color, accepted legend letter size, accepted marker length.
  - 2) Duct label Contents: Include identification of duct service using same designations or abbreviations on Drawings, duct size, and an arrow indicating flow direction.
  - 3) Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
  - 4) Lettering Size: At least 2 in. high.
  - 5) Color Coding:



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<b>HVAC Ductwork</b>	<b>Background Color</b>	<b>Lettering Color</b>
Exhaust Air Ducts	Yellow	Black
Outside Air Ducts	Green	White
Return Ducts	Green	White
Supply Ducts	Green	White

- b) Preferred: No preferences
- c) Disallowed: None

### E. Valve Tags:

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Craftmark Identification Systems
    - 2) Seton Identification Products
    - 3) MSI Marking Services, Inc.
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Attach to handwheel or stem of each control and line shutoff valve installed under this Section. Stamped or engraved with minimum 1 inch high designating numbers.
    - 2) Tag material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
    - 3) Fasteners: Heavy brass or S-hook.
    - 4) Valve Identification tags shall have the following abbreviations plus valve number. Any discrepancies or questions to this guideline shall be coordinated and confirmed with FPM Engineering.
    - 5) Valve tags shall all be of brass material and type, regardless of hydronic system type or service.

<b>Service</b>	<b>Tag Lettering</b>
Chilled Water	CHW
Heating Hot Water	HHW
Condenser Water	CW
High Pressure Steam	HPS

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Service	Tag Lettering
Low Pressure Steam	LPS
Pumped Condensate	PC
Gravity Condensate	GC
Refrigerant	REF

- b) Preferred: No preferences
- c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. Thermostats for all de-centralized zones or equipment shall be labeled, on their “face” with the same approved designation of the equipment in controls.
2. Properly identify each piece of equipment and controls pertaining to thereto by nameplates mounted on equipment and controls using round head brass machine screws, pop rivets, or contact cement.
3. Locate equipment labels where accessible and visible.
4. Refer to the following table for piping, ductwork, and valve labels:

Type	Applicable Locations	Install Locations
Piping	<ul style="list-style-type: none"> <li>- Exposed or above accessible ceilings in finished spaces</li> <li>- Machine rooms</li> <li>- Accessible maintenance spaces such as shafts, tunnels, and plenums</li> <li>- Exterior exposed locations</li> </ul>	<ol style="list-style-type: none"> <li>1. Within one foot of each valve or control device.</li> <li>2. Near each branch connection and riser take-off.</li> <li>3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.</li> <li>4. Near major equipment items and other points of origination and termination.</li> <li>5. On all horizontal runs 20 feet maximum but not less than once in each room at entrance and exit of each concealed space.</li> <li>6. On piping above removable acoustical ceilings.</li> </ol>

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Type	Applicable Locations	Install Locations
Ductwork	<ul style="list-style-type: none"> <li>- Exposed or above accessible ceilings in finished spaces</li> <li>- Machine rooms</li> <li>- Accessible maintenance spaces such as shafts, tunnels, and plenums</li> <li>- Exterior exposed locations</li> </ul>	<ol style="list-style-type: none"> <li>1. Within one foot of each control device.</li> <li>2. Near each branch connection and riser takeoff.</li> <li>3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.</li> <li>4. Near major equipment items and other points of origination and termination.</li> <li>5. On all horizontal runs spaced 20 feet maximum but not less than once in each room at entrance and exit of each concealed space.</li> <li>6. On ducting above removable acoustical ceilings.</li> </ol>
Valve Tags	See install locations.	Tag all valves except riser drains, strainer drains, and valves within factory-fabricated equipment units.

5. Provide stick on dots to locate equipment above T-bar type panel ceiling. Dots shall be located in corner of panel closest to equipment. Provide the following colors for designation:

Type	Color
HVAC related (equipment, dampers, valves, terminal boxes, etc.)	Blue
Plumbing Valves	Green
Controls	Red

Preferred: No preferences

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B. Disallowed: None

### **5. EVALUATION or COMMISSIONING**

A. List of items or systems requiring testing, evaluation, verification, or commissioning: None.

B. Documentation required: None

C. Required testing protocols beyond normal Commissioning and TAB protocols: None.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 0593 TESTING, ADJUSTING AND BALANCING FOR HVAC

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Commissioning Standard Guidelines separate of this document.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Submit the Engineer's Test & Air Balance Specification for review to FPM Engineering at 100% DD with proposed procedures for all central HVAC systems as a means of qualifying proposed contractors and confirming extent and appropriateness of services to be provided.
    - b) The TAB Contractor shall be a sub-contractor to the General Contractor and shall maintain a list of deficiencies for the General Contractor, with review by owner's representative on demand.
    - c) The Mechanical Contractor shall coordinate his work with the TAB Contractor and correct any system deficiency identified with the General Contractor's TAB agent.
    - d) The procedure and results for items in this section are to be retained by the Mechanical Contractor for delivery to the owner/design consultant on request.
    - e) TAB agent shall submit a pre-work set of TAB forms filled in with all design data for systems to be tested.
    - f) Testing procedures, as outlined within initial TAB contractor submittal, shall be specific to system and distribution types, as applicable to individual project design. References to generic procedures and systems that do not apply shall be removed, and any non-traditional procedures highlighted for subsequent review and approval.
  - 2. Preferred: No preferences
  - 3. Disallowed:
    - a) The TAB Contractor shall not be a sub-contractor to the Mechanical Contractor.

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- B. Quality Assurance requirements beyond standard 1 year warranty: AABC certificate of guarantee.

### 3. PRODUCT REQUIREMENTS

A. TAB:

1. Manufacturers:
  - a) Required:
    - 1) Only AABC certified testing, adjusting and balancing agencies are allowed.
  - b) Preferred:
    - 1) American Air Balance
    - 2) Los Angeles Air Balance Company, Inc.
    - 3) Approved equal
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required: No requirements
  - b) Preferred: No preferences
  - c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

A. Required:

1. Balance air flows to the following tolerances:

System	Tolerance	Comments
Supply Diffuser	0 to +10% of design	Document that intended room pressurization with regard to adjacent spaces has been achieved.
Return	+/- 5% of design	
Exhaust	0 to -10% of design	

2. Balance water flows to the following tolerances:

System	Tolerance	Comments
Pumps	0 to +10% of design	
Equipment	0 to 5% of design	

3. Provide Room NC level testing as noted in Section 13 48 00 to confirm HVAC noise levels are within requirements also stated in that Section.
4. Refer to Section 23 00 00 for "pre-read" requirements in retrofit applications.

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- B. Preferred: No preferences
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: None.
- B. Documentation required:
  - 1. 75%, 95%, 100% Testing Adjusting and Balancing Reports.
  - 2. Continuous System Deficiency Report on site.
  - 3. In-person witnessing: Provide random sampling of the following items as witnessed by the Owner's Representative:
    - a) 10% of diffusers or grilles
    - b) 20% of air handling units
    - c) 20% of pumps
    - d) 20% of terminal air side and hydronic equipment
- C. Required testing protocols beyond normal Commissioning and TAB protocols:
  - 1. AABC protocols and forms but adjusted to meet unique needs of project

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 0713 DUCT INSULATION

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 31 13.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Engineering Documents shall show explicit code compliance regarding energy efficiency and flame spread/smoke development.
    - b) Continuous insulation on supply ductwork shall be provided along its entire length.
    - c) Insulation shall be provided whenever outside air, supply, return or elevated temperature exhaust ductwork is within a plenum cavity.
    - d) Minimum insulation R-values shall be as defined within the current versions of the Ca. Mechanical Code, Appendix "E", Table E 503.7.2(1) and the Ca. Energy Code, Table 150.2-A.
  - 2. Preferred:
    - a) Provide interior lining only in cases where specific acoustical requirements are dictated. Refer to Section 23 48 00.
  - 3. Disallowed:
    - a) Interior lining shall not be specified as the sole means of ductwork insulation.
    - b) Interior lining shall not be provided within 10 feet downstream of a duct mounted humidifier.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required

### 3. PRODUCT REQUIREMENTS

- A. Duct Insulation:
  - 1. Manufacturers:
    - a) Required: No requirements



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- b) Preferred: No preferences
- 2. Component Characteristics:
  - a) Required:
    - 1) Provide a finishing material around all insulation containing fibers to prevent shedding of fibers into surrounding plenum spaces or cavities.
  - b) Preferred: No preferences

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

- 1. Provide special protection for insulating materials from damage as follows:

Location	Insulation Type	Jacket Type
Mechanical rooms (duct located $\leq$ 8' AFF)	Rigid	Canvas Jacket
Exposed ductwork, indoor. (duct located $\leq$ 8' AFF).	Rigid	Minimum 26 gage galvanized sheet metal.
Outdoors	Rigid	Minimum 0.016 inch thick aluminum jacket.

- 2. Provide consistent and appropriate means of attachment for insulation onto ductwork so as to not compromise how these materials are secured. As a minimum provide 100% coverage on adhesive and weld pins spaced at 16" on center with at least one central line of pins per side of duct for ducts smaller than 18". Provide pins within 3" of insulation joints/laps.
- 3. Maintain a continuous vapor barrier so the insulation material integrity shall not be compromised at insulation joint locations.
- 4. Before installing duct installation, sheet metal ductwork shall be clean, dry and tightly sealed. Ductwork should have completed pressure testing, witnessed by the USC Project Manager and FPM Engineering.

#### B. Preferred: No preferences

#### C. Disallowed: None

### 5. EVALUATION OR COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: None.
- B. Documentation required: None.
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None.

END OF DOCUMENT

# USC DESIGN GUIDELINES

## 23 0719 HVAC PIPING INSULATION

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13 and Section 23 22 13.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Engineering Documents shall show explicit code compliance regarding energy efficiency and flame spread/smoke development.
    - b) Provide appropriate factory kits for the insulation of pipe fittings.
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None required

### 3. PRODUCT REQUIREMENTS

- A. Above Ground Piping Insulation:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: No preferences
    - c) Disallowed: Elastomeric insulation should not be used. Application of such shall be submitted for approval and should be kept to a minimum when justifying the use of such.
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide appropriate factory kits for the insulation of pipe fittings.
      - 2) Provide a finishing material around all insulation containing fibers to prevent shedding of fibers into surrounding plenum spaces or cavities.

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- b) Preferred:
    - 1) Insulation shall be factory fabricated and installed in a manner to allow easy future removal and re-attachment at locations requiring maintenance such as fittings, valves, equipment, etc.
  - c) Disallowed: None
- B. Above Ground Vertical Riser Clamp:
- 1. Manufacturers:
    - a) Required:
      - 1) Pipe Shields Inc.
      - 2) Or equal
    - b) Preferred: No preferences
    - c) Disallowed: Factory or field assembled riser clamps systems that cause direct contact of pipe support and carrier pipe, does not provide protection to insulation from damage and point of support, and interrupts a continuous insulation system vapor barrier.

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Provide insulation and jacketing materials as follows:

Pipe Type	Location Type	Insulation Type	Jacket Type
Above Ground Piping: CHW and HHW	Exposed in Mechanical rooms 8' and below	Pre-formed Rigid Fiberglass	PVC (ASTM E84, 20 mil thickness) *
	Parking Garages	Pre-formed Rigid Fiberglass	PVC (ASTM E84, 20 mil thickness) *
	Outdoors	Pre-formed Rigid Fiberglass	Aluminum (stucco embossed, 0.016" or 0.024" depending on impact exposure)
	All piping not covered below	Pre-formed Rigid Fiberglass	None
Above Ground Piping: Steam, Condensate	All piping	Pre-formed Rigid Fiberglass or Phenolic Foam	Aluminum (stucco embossed, 0.016" or 0.024" depending on impact exposure)
Above Ground Piping: Refrigerant Suction Lines	Horizontal runs within the building	Pre-formed Rigid Fiberglass	None
	Outdoors	Pre-formed Rigid Fiberglass	Aluminum (stucco embossed, 0.016" or 0.024" depending on impact exposure)

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Above Ground Piping: Condensate Drain	Within building (plenum, conditioned space)	Closed-cell Foam	None
* Refer to Section 23 0553 for pipe cover/color scheme.			

<b>Minimum Pipe Insulation Thickness</b>						
<b>Piping System Type</b>	<b>Temp. Range (°F)</b>	<b>&lt; 1"</b>	<b>1 to &lt; 1.5"</b>	<b>1.5 to &lt; 4"</b>	<b>4" to &lt; 8"</b>	<b>8" and larger</b>
<b>Space Heating Systems</b>						
Heating Hot Water	Up to 200	1.5	1.5	2.0	2.0	2.0
<b>Space Cooling Systems</b>						
Chilled Water	40-60	0.5	0.75	1.0	1.0	1.0
Refrigerant	Below 40	1.0	1.5	1.5	1.5	1.5
*Condensate drain lines from HVAC equipment located within buildings, in rooms, inside walls and above ceilings.	N/A	0.5	0.5	0.5	N/A	N/A
*At all locations where condensation on pipe surface may cause damage to surrounding materials or equipment.						

2. A continuous vapor barrier must be maintained and integrity intact for protection from external elements, for both horizontal and vertical pipe installations.
3. Install rigid pre-insulated pipe supports to protect from compression of insulation material due to point loads.
4. Provide aluminum sleeves at all pipe support points, between hanger support and exterior layer of insulating systems, to protect from compression of insulation material due to point loads.
5. Install insulation on piping accessories requiring future re-occurring access and service with factory fabricated insulation covers that are easily removed and re-applied.
6. Insulation shall not be installed until the following have been completed and documentation has been and submitted to FPM Engineering for approval and record:
  - a) Cleaning and flushing
  - b) Pressure Testing
  - c) Vertical pipe riser clamp assembly, along with means of insulation and securement.

**B. Preferred:**

1. It is preferred for above ground installations to provide prefabricated / preformed fittings, individual valves or valve kits, and accessories. Field-applied insulation should be kept to a minimum.

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2. It is preferred that pre-cut flexible fiberglass is used at joints and equipment requiring maintenance to allow ease of removal and replacement without adversely affecting the surrounding insulation.
3. Pre-insulated (as opposed to field insulated) vertical pipe riser clamp assembly, with integrated pipe sleeves and thrust plates shall be provided.
4. Metal jacketing material for all steam and steam condensate piping above ground and within building.

C. Disallowed: None

### **5. EVALUATION OR COMMISSIONING**

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: None.
- B. Documentation required: None.
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None.

**END OF DOCUMENT**

**SECTION 23 0801 - BAS SYSTEM COMMISSIONING**

*Note to the Design AE: The AE and project manager should discuss the project with USC. There is a ‘Preface’ document describing how to employ this and other USC controls-related Guide Specifications. The AE is instructed to consult the Preface document for guidance on the generic BACnet nature of this specification, methods for deleting non-applicable text, and the use and deletion of Editor’s Note’s before proceeding to customize this specification.*

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**PART I. GENERAL**

**1.01 SECTION INCLUDES**

- A. BAS and equipment testing and start-up
- B. Validation of proper and thorough installation of BAS and equipment
- C. Functional testing of control systems
- D. Documentation of tests, procedures, and installations
- E. Coordination of BAS training
- F. Documentation of BAS Operation and Maintenance materials

**1.02 RELATED SECTIONS:**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

- B. Section 23 0010 – *{Insert Applicable Specification Section}*
- C. Section 23 0900 – BAS General Requirements
- D. Section 23 0901 - BAS Basic Materials and Devices
- E. Section 23 0902 - BAS Operator Interfaces
- F. Section 23 0903 - BAS Field Panels
- G. Section 23 0904 - BAS Communication Devices
- H. Section 23 0905 - BAS Software and Programming
- I. Section *{Insert Applicable Specification Section}* – Sequence of Operation

### 1.03 GENERAL DESCRIPTION

- A. This section defines responsibilities of the Controls Contractor to commission the BAS.

*Edit this to clarify whether there is a formal Cx process and indicate responsibilities.*

- B.

*The following is written based on the use of a separate Commissioning Authority (CA). If that is not the case on the project, the Contractor must still start up and commission the BAS. Therefore edit the responsibilities as appropriate for the project commissioning requirements.*

### 1.04 CONTRACTOR RESPONSIBILITIES

- A. Completely install and thoroughly inspect, startup, test, adjust, balance, and document all systems and equipment.
- B. [\[Assist Commissioning Authority in\]](#) Perform verification and performance testing. This will generally include the following:
  - 1. [\[Attend Commissioning \(Cx\) progress and coordination meetings.\]](#)
  - 2. [\[Prepare and submit required draft forms and systems information.\]](#)
  - 3. Establish trend logs of system operation as specified herein.
  - 4. Demonstrate system operation.
  - 5. Manipulate systems and equipment to facilitate testing.
  - 6. Provide instrumentation necessary for verification and performance testing.
  - 7. Manipulate control systems to facilitate verification and performance testing.
  - 8. Train the University of Southern California’s Representatives as specified in Part III of this section.

*The following two items only apply to formal commissioning processes. Edit as applicable.*

- C. Provide an BAS Technician to work at the direction of Commissioning Authority for software optimization assistance for minimum of [24] hours for Scope 1 and [24] hours for Scope 2. Refer to Part 3 for a description of the software optimization.
- D. **Compensation for Retesting:** Contractor shall compensate the University for site time necessitated by incompleteness of systems or equipment at time of functional performance testing. All testing failures, which require on-site time for retesting, will

be considered actual damages to the University. All parties under contract with the University who are affected by the retesting shall be included in the contract modification.

*Edit the following to suit the program and application.*

## **1.05 SEQUENCING**

- A. The following list outlines the general sequence of events for submittals and commissioning:
1. Submit product data and shop drawings, and receive approval.
  2. Submit BAS logic documentation, and receive approval.
  3. Submit Start-Up Checklists and manufacturer's start-up procedures for all equipment provided by the BAS Contractor.
  4. Install BAS.
  5. Submit BAS Start-Up Test Agenda and Schedule for review.
  6. Receive BAS start up Test Agenda/schedule approval.
  7. Simulate sequencing and debug program off-line to the extent practical.
  8. Load software on controls and place systems under BAS control where applicable during a scheduled outage.
  9. Perform BAS start up where applicable during a scheduled outage.
  10. Prepare and initiate trend log data storage and format trend graphs.
  11. Submit completed BAS Start-Up Reports and initial draft of the O&M Manuals.
  12. Receive BAS Start Up Report approval and approval to schedule Demonstrations and Commissioning.
  13. Demonstrate systems to [Commissioning Authority] [and] [the University].
  14. Interface testing of EBI to the Building BAS
  15. Submit Trend Logs in format specified.
  16. Receive demonstration approval and approval to schedule Acceptance Period.
  17. Submit Training Plan.
  18. Train the University on BAS operation and maintenance.
  19. Substantial Completion
  20. Begin Acceptance Phase.
  21. Two week Operational Test.
  22. Perform Functional Performance Testing.
  23. Receive Acceptance Period approval, which is Functional Completion for the BAS.
  24. Train the University on final sequences and modes of operation.
  25. Install framed control drawings.
  26. Provide Level 1 password access to the University.
  27. Revise and re-submit record drawings and O&M Manuals.
  28. Final Acceptance
  29. Begin Warranty Phase.



30. Schedule and begin Opposite Season acceptance period.
31. Receive Opposite Season acceptance period approval
32. Submit as-built drawings and O&M Manuals.
33. Update framed control drawings.
34. Complete University Training.
35. End-of-Warranty date/period

## **PART II. PRODUCTS**

### **2.01 INSTRUMENTATION**

- A. Instrumentation required to verify readings and test the system and equipment performance shall be provided by Contractor [\[and made available to Commissioning Authority\]](#). Generally, no testing equipment will be required beyond that required to perform Contractors work under these Contract Documents. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted.

### **2.02 TAB & COMMISSIONING PORTABLE OPERATORS TERMINAL**

- A. For new projects, Contractor shall provide a portable workstation to facilitate Testing, Adjusting, and Balancing (TAB) and calibration. This device shall support all functions and allow querying and editing of all parameters required for proper calibration and start up. Software tool
- B. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the sensor or at the terminal box. Otherwise a wireless system shall be provided to facilitate this local functionality.

## **PART III. EXECUTION**

*Edit the following to suit the application.*

### **3.01 BAS START-UP TESTING, ADJUSTING, CALIBRATION**

- A. Work and/or systems installed under this Division shall be fully functioning prior to functional performance testing phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this Contract, as described below:
  1. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
  2. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
  3. Verify integrity/safety of all electrical connections.
  4. Coordinate with TAB subcontractor to obtain control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB contractor, and note any TAB deficiencies in the BAS Start-Up Report:
    - a) Optimum duct static pressure setpoints for VAV air handling units.

- b) Minimum outside air damper settings for air handling units
- c) Optimum differential pressure setpoints for variable speed pumping systems.
- d) Calibration parameters for flow control devices such as VAV boxes and flow measuring stations.
  - 1) BAS contractor shall provide software tool as a minimum to the TAB [and CA] to facilitate calibration. Connection for any given device shall be local to it (i.e. at the VAV box or at the thermostat). Hand-held device or portable operator's terminal shall allow querying and editing of parameters required for proper calibration and start-up.
- 5. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the BAS Start Up Report.
- 6. Check and set zero and span adjustments for all transducers and transmitters.
- 7. For dampers and valves:
  - a) Check for adequate installation including free travel throughout range and adequate seal.
  - b) Where loops are sequenced, check for proper control without overlap.
- 8. For actuators:
  - a) Check to insure that device seals tightly when the appropriate signal is applied to the operator.
  - b) Check for appropriate fail position, and that the stroke and range is as required.
  - c) For pneumatic operators, adjust the operator spring compression as required to achieve close-off. If positioner or volume booster is installed on the operator, calibrate per manufacturer's procedure to achieve spring range indicated. Check split-range positioners to verify proper operation. Record settings for each device in the BAS Start up Report.
  - d) For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges.
- 9. Check each digital control point by making a comparison between the control command at the controller and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the Operator Interface display. Record the results for each device in the BAS Start-Up Report.
- 10. For outputs to reset other manufacturer's devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.

11. Verify proper sequences by using the approved checklists to record results and submit with BAS Start-Up Report. Verify proper sequence and operation of all specified functions.
12. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.

*Edit to suit project*

13. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Start Up Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted):
  - a) Duct air temperature:  $\pm 1^{\circ}\text{F}$ .
  - b) Space Temperature:  $\pm 2^{\circ}\text{F}$
  - c) Chilled Water:  $\pm 1^{\circ}\text{F}$
  - d) Hot water temperature:  $\pm 3^{\circ}\text{F}$ .
  - e) Duct pressure:  $\pm 0.25''$  w.g.
  - f) Water pressure:  $\pm 1$  psid
  - g) Duct or space Humidity:  $\pm 5\%$
  - h) Air flow control:  $\pm 5\%$  of setpoint velocity. [For fume hoods  $\pm 10\%$  on full sash travel (from min to max in 3 seconds) within 3 seconds. Refer to Section XXXXX for fume hood acceptance requirements.] [For minimum OA flow loops being reset from  $\text{CO}_2$ , response to upset max time is one hour.]
  - i) Space Pressurization (on active control systems):  $\pm 0.05''$  wg with no door or window movements.
14. **For interface and DDC control panels:**
  - a) Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
  - b) Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
  - c) Check power supplies for proper voltage ranges and loading.
  - d) Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
  - e) Check for adequate signal strength on communication networks.
  - f) Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
  - g) Ensure that all outputs and devices fail to their proper positions/states.

- 
- h) Ensure that buffered and/or volatile information is held through power outage.
  - i) With all system and communications operating normally, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
  - j) Check for adequate grounding of all DDC panels and devices.
15. For Operator Workstation:
- a) Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
  - b) Output all specified BAS reports for review and approval.
  - c) Verify that the alarm logging and or printing is functional and per requirements.
  - d) Verify that trends are archiving to disk and provide a sample to the [\[Commissioning Authority and\]](#) University for review.
  - e) Verify that paging/dial-out alarm annunciation is functional.
  - f) Verify the functionality of remote Operator Interfaces and that a robust connection can be established consistently.
  - g) Verify that required third party software applications required with the project are installed and are functional.
16. Verify proper interface with fire alarm system.
- B. **Submit Start-Up Test Report:** Report shall be completed, submitted to [\[Commissioning Authority\]](#) , and approved prior to functional performance testing.

### 3.02 SENSOR CHECKOUT AND CALIBRATION

- A. **General Checkout:** Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading of each other for pressure. Tolerances for critical applications may be tighter.
- B. **Calibration:** Calibrate all sensors using one of the following procedures:
1. **Sensors without Transmitters - Standard Application:** Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.
  2. **Sensors with Transmitters - Standard Application:** Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature

data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until the ammeter reads 4 mA. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the operator interface. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

- C. **Sensor Tolerance:** Sensors shall be within the tolerances specified for the device. Refer to Section 25951.

### **3.03 COIL VALVE LEAK CHECK**

- A. Verify proper close-off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensors on each side of coil to be within 0.5°F of each other. Via the Operator Interface, command the valve to close. Energize fans. After 5 minutes observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3°F of the water supply temp, leakage is probably occurring. If it appears that it is occurring, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

### **3.04 VALVE STROKE SETUP AND CHECK**

- A. For all valve and actuator positions checked, verify the actual position against the Operator Interface readout.
- B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to various few intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

### **3.05 VARIABLE SPEED DRIVE SETUP AND CHECK**

- A. VFD's shall be properly started and checked out as part of the functional testing of control systems.

### **3.06 BAS DEMONSTRATION/FUNCTIONAL TESTING**

- A. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the [\[Commissioning Authority and\]](#) University. Schedule the demonstration with the University's representative 1 week in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to be demonstrated to conform with Contract specifications, so as to require scheduling of additional site

visits by the [Commissioning Authority] University for re-demonstration, Contractor shall reimburse the University for costs of subsequent [Commissioning Authority] site visits.

- B. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor-supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.
- C. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the University [and/or Commissioning Authority]. defined
- D. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:
  - 1. Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
  - 2. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
  - 3. Demonstrate that remote communication abilities are in accordance with these Specifications.
  - 4. Demonstrate correct calibration of input/output devices using the same methods specified for the Start-Up Tests. A maximum of 10 percent of I/O points shall be selected at random by the [Commissioning Authority and/or] University for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random [by Commissioning Authority] for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.
  - 5. Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be as submitted and approved.
  - 6. Demonstrate that all DDC programs accomplish the specified sequences of operation.
  - 7. Demonstrate that all DDC programs accomplish alarm and safety functions
  - 8. Demonstrate that the panels automatically recover from power failures, as specified.
  - 9. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements of these Specifications.
  - 10. Identify access to equipment selected [by Commissioning Authority] [by the University]. Demonstrate that access is sufficient to perform required maintenance.

11. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.
- E. BAS Demonstration shall be completed and approved prior to Substantial Completion.

### **3.07 BAS ACCEPTANCE PERIOD**

- A. After approval of the BAS Demonstration and prior to Contract Close Out Acceptance Phase shall commence. [Acceptance Period shall not be scheduled until all HVAC systems are in operation and have been accepted, all required cleaning and lubrication has been]
- B. **Operational Test:** At the beginning of the Acceptance Phase, the system shall operate properly for two weeks without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications. At the end of the two weeks, contractor shall forward the trend logs to the [Commissioning Authority/] University for review. [Commissioning Authority/] University shall document any problems requiring contractor attention.
  1. Contractor shall correct problems and provide notification to the University's representative that all problems have been corrected. The Acceptance Period shall be restarted at a mutually scheduled time for an additional one-week period. This process shall be repeated until Commissioning Authority/University confirms completion of all open items.
- C. During the Acceptance Period, the contractor shall maintain a hard copy log of all alarms generated by the BAS. For each alarm received, Contractor shall diagnose the cause of the alarm, and shall list on the log for each alarm, the diagnosed cause of the alarm, and the corrective action taken. If in the Contractor's opinion, the cause of the alarm is not the responsibility of the Contractor, Contractor shall immediately notify the University's representative.

### **3.08 TREND LOGS**

- A. Controls Contractor shall configure and analyze all trends required under Section 25955.

### **3.09 TREND GRAPHS**

- A. Controls Contractor working in conjunction with the University FMS shall create trend graphs as defined by commissioning authority specified in Section 25955 shall generally be used during the Acceptance Phase to facilitate and document testing. Prepare controller and workstation software to display graphical format trends during the Acceptance Period. Trend graphs shall demonstrate compliance with contract documents.
- B. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

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**3.10 WARRANTY PHASE BAS OPPOSITE SEASON TRENDING AND TESTING: OPTIONAL**

- A. **Trending:** throughout the Warranty Phase, trend logs shall be maintained as required for the Acceptance Period. Contractor shall forward archive trend logs to the [Commissioning Authority/] University for review upon [Commissioning Authority/] University request. [Commissioning Authority/] University will review these and notify contractor of any warranty work required.
- B. **Opposite Season Testing:** Within 6 months of completion of the Acceptance Phase, [Commissioning Authority/] University shall schedule and conduct Opposite Season functional performance testing. Contractor shall participate in this testing and remedy any deficiencies identified.

*The following item only applies to a formal Cx process.*

**3.11 SOFTWARE OPTIMIZATION ASSISTANCE**

- A. The Contractor shall provide the services of a BAS Technician as specified above at the project site to be at the disposal of the [Commissioning Authority/] University. The purpose of this requirement is to make changes, enhancements and additions to control unit and/or workstation software that have been identified by the [Commissioning Authority/] University during the construction and commissioning of the project and that are beyond the specified Contract requirements. The cost for this service shall be determined on a T&M basis with the bid. Requests for assistance shall be for contiguous or non-contiguous 8-hour days, unless otherwise mutually agreed upon by Contractor, [Commissioning Authority,] and the University. The University's representative shall notify contractor 2 days in advance of each day of requested assistance.
- B. The BAS Technician provided shall be thoroughly trained in the programming and operation of the controller and workstation software. If the BAS Technician provided cannot perform every software task requested by the [Commissioning Authority/] University in a timely fashion, contractor shall provide additional qualified personnel at the project site as requested by the [Commissioning Authority/] University, to meet the total specified requirement on-site.

**3.12 BAS OPERATOR TRAINING AND O&M MANUALS**

- A. Reference USC Standard Provide up to 4 complete sets of the approved Operations and Maintenance (O&M) Manuals (hard copy and one electronic copy) to be used for training.
- B. Contractor shall submit a Training Plan for the scope of training for which (s)he is responsible. Training Plan shall be forwarded to the Division 25 Contractor who will compile, organize, format, and forward to the Engineer for review.
- C. **On-Site Training:** Provide services of controls contractor's qualified technical personnel for [one] 8-hour days to instruct the University 's personnel in operation and maintenance of BAS. Instruction shall be in classroom setting at the project site for appropriate portions of the training. Training may be in non-contiguous days at the request of the University. The University's representative shall notify contractor 1 week in advance of each day of requested training. The Contractor's designated



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training personnel shall meet with the Engineer and University's representative for the purpose of discussing and fine-tuning the training agenda prior to the first training session. Training agenda shall generally be as follows:

1. **Basic Operator Workstation (OWS) Training** – For all potential users of the OWS:
  - a) Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of controller portable and built-in operator interface device display capabilities.
  - b) Brief overview of the various parts of the O&M Manuals, including hardware and software programming and operating publications, catalog data, controls installation drawings, and DDC programming documentation.
  - c) Demonstration of workstation login/logout procedures, password setup, and exception reporting.
  - d) Demonstration of workstation menu penetration and broad overview of the various workstation features.
  - e) Overview of systems installed.
  - f) Present all site-specific point naming conventions and points lists, open protocol information, configuration databases, back-up sequences, upload/download procedures, and other information as necessary to maintain the integrity of the BAS.
  - g) Overview of alarm features.
  - h) Overview of trend features.
  - i) Overview of workstation reports.
2. **BAS Hardware Training** – For Maintenance and Control Technicians
  - a) Review of installed components and how to install/replace, maintain, commission, and diagnose them
3. **BAS Technician Training**
  - a) Introduction to controller programming and overview of the programming application interface.
  - b) General review of sequence of operation and control logic for the project site, including standalone and fail-safe modes of operation.
  - c) Uploading/Downloading and backing up programs.
  - d) Network administration.
  - e) Review of setpoint optimization and fine-tuning concepts.

*END OF SECTION 23 0801*

**SECTION 23 0900 - BAS GENERAL**

***Note to the Design AE:*** *The AE and project manager should discuss the project with USC. There is a 'Preface' document describing how to employ this and other USC controls-related Guide Specifications. The AE is instructed to consult the Preface document for guidance on the nature of this specification, methods for deleting non-applicable text, and the use and deletion of Editor's Note's before proceeding to customize this specification.*

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**PART I. GENERAL****1.01 SECTION INCLUDES**

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- C. Quality Assurance
- D. System Architecture
- E. Distributed Processing Units/Quantity and Location
- F. Demolition and Reuse of Existing Materials and Equipment
- G. Sequence of Work

### 1.02 RELATED DOCUMENTS

- A. Section *{Insert Applicable Specification Section}* -Basic Mechanical Requirements.
- B. Section 23 0901 – Building Automation System (BAS) Basic Materials, Interface Devices, and Sensors
- C. Section 23 0902 - BAS Operator Interfaces
- D. Section 23 0903 - BAS Field Panels
- E. Section 23 0904 -BAS Communication Devices
- F. Section 23 0905 - BAS Software and Programming
- G. Section 23 0993 - Sequences of Operation
- H. Section 23 0801 – BAS Commissioning

### 1.03 DESCRIPTION OF WORK

- A. The distributed digital control (DDC) and Building Automation System(BAS) defined in this specification shall seamlessly interface with the University of Southern California’s Honeywell Enterprise Building Integrator (EBI), and shall utilize the BACnet communication requirements as defined by ASHRAE/ANSI 135-2016, or Echelon LonTalk Protocol as defined by EIA/CEA-709.1-A-1999 for all communication between building automation systems and the EBI operator workstation directly. Towards this end, contractor shall provide a router/gateway(s) as necessary to facilitate all specified objects and services and have them configured/mapped as applicable. Incorporation of these objects and services into the EBI system is required under this project. EBI point server expansion to cover software and hardware shall be included in the project.
- B. Contractor shall furnish and install a direct digital control and Building Automation System(BAS). The new BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic and/or pneumatic actuation of dampers and valves to perform control sequences and functions specified. The BAS for this project will generally consist of monitoring and control of systems listed below. Reference also, control drawings, sequences of operation, and points lists.

- C. The systems to be controlled under work of this section basically comprise *{describe the scope of the project.}* The HVAC systems being controlled are *{describe the configuration of and the type of mechanical systems included in the project.}* This Section defines the manner and method by which these controls function.

#### 1.04 PROCUREMENT

- A. The BAS, digital control and communications components installed, as work of this contract shall be an integrated distributed processing system of the following manufacturer. No other vendor's products will be considered as substitutions.
- B. Acceptable Manufacturers
1. Honeywell Factory Branch
  2. Johnson Controls Factory Branch
  3. Siemens Factory Branch

#### 1.05 QUALITY ASSURANCE

*Use "A" to define any specific qualifications needed; otherwise leave "Reserved"*

- A. **Reserved.**

*The following requirement is relative to the demonstrated history of the product line they are proposing. Edit to suit project.*

- B. **Product Line Demonstrated History:** The product line being proposed for the project must have an installed history of demonstrated satisfactory operation for a length of [2] years since date of final completion in at least [10] installations of comparative [size] [and complexity]. Submittals shall document this requirement with references.

*The following requirement relates to the actual installing contractor..*

- C. **Installer's Qualifications:** Firms specializing and experienced in control system installations for not less than [5] years. Firms with experience in DDC installation projects with point counts equal to this project and systems of the same character as this project. Experience starts with awarded final completion of previous projects. Submittals must document this experience with references.

*The following requirement relates to the actual installing contractor's experience with the proposed product line. This is where you specifically eliminate an experienced controls company that just picked up the line. This requirement is not as clearly applicable as the previous one. Edit to suit approach.*

- D. **Installer's Experience with Proposed Product Line:** Firms shall have specialized in and be experienced with the installation of the proposed product line for not less than [two] years from date of final completion on at least [3] projects of similar size and complexity. Submittals shall document this experience with references.

*The following requirements relate to the key individuals who will be working on the project.*

- E. **Installer's Field Coordinator and Sequence Programmer Qualifications:** Individual(s) shall specialize in and be experienced with control system installation for not less than 5 years. Proposed field coordinator shall have experience with the installation of the proposed product line for not less than [3] projects of similar size and complexity. Installer shall submit the names of the proposed individual and at least one alternate for each duty. Submittals shall document this experience with references. **{Edit as applicable}** The proposed individuals must show proof of the following training:
1. **Product Line Training:** Individuals overseeing the installation and configuration of the proposed product line must provide evidence of the most advanced training offered by the Manufacturer on that product line for installation and configuration
  2. **Programming Training:** Individuals involved with programming the site-specific sequences shall provide evidence of the most advanced programming training offered by the vendor of the programming application offered by the Manufacturer.
  3. **LonTalk Training:** The LonTalk BAS shall be furnished, engineered and installed by individuals who have completed the LonMark Network Design, Installation and Maintenance Training Program. Certifications shall be provided.
  4. **Bacnet Training:** The Bacnet BAS shall be furnished, engineered and installed by individuals shall provide evidence of the most advanced programming training offered by the vendor of the programming application offered by the Manufacturer. Certifications shall be provided.
- F. **Installer's Service Qualifications:** The installer must be experienced in control system operation, maintenance and service. Installer must document a minimum 5 year history of servicing installations of similar size and complexity. Installer must also document at least a one year history of servicing the proposed product line.
- G. **Installer's Response Time and Proximity**
1. Installer must maintain a fully capable service facility within a [45 mile] radius of the project site. Service facility shall manage the emergency service dispatches and maintain the inventory of spare parts.
  2. Emergency response times are listed below in this section. Installer must demonstrate the ability to meet the response times.

## 1.06 CODES AND STANDARDS

- A. The following codes and standard intended to apply as applicable as not all will apply to all installations
- B. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
1. ASHRAE 135-2016: BACnet - A Data Communication Protocol for Building Automation and Control Networks. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. 2016
- C. Electronics Industries Alliance
1. EIA-709.1-A-99: Control Network Protocol Specification

2. EIA-709.3-99: Free-Topology Twisted-Pair Channel Specification
  3. EIA-232: Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
  4. EIA-458: Standard Optical Fiber Material Classes and Preferred Sizes
  5. EIA-485: Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems.
  6. EIA-472: General and Sectional Specifications for Fiber Optic Cable
  7. EIA-475: Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications
  8. EIA-573: Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications
  9. EIA-590: Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications
- D. Underwriters Laboratories
1. UL 916: Energy Management Systems.
- The following rating is required only for devices used for smoke control purposes. If these are not intended, delete.*
2. UUKL 864: UL Supervised Smoke Control
- E. NEMA Compliance
1. NEMA 250: Enclosure for Electrical Equipment
  2. NEMA ICS 1: General Standards for Industrial Controls.
- F. NFPA Compliance
1. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
  2. NFPA 70 National Electrical Code (NEC)
- G. Institute of Electrical and Electronics Engineers (IEEE)
1. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
  2. IEEE 802.3: CSMA/CD (Ethernet – Based) LAN
  3. IEEE 802.4: Token Bus Working Group (ARCNET – Based) LAN

*Edit the definitions below to apply for a given project.*

## 1.07 DEFINITIONS

- A. **Accuracy:** As stated in 230913, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.
- B. **Advanced Application Controller (AAC):** A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications.

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- C. **Application Protocol Data Unit (APDU):** A unit of data specified in an application protocol and consisting of application protocol control information and possible application user data (ISO 9545).
  - D. **Application Specific Controller (ASC):** A device with limited resources relative to the Advanced Application Controller (AAC). It may support a level of programming and may also be intended for application-specific applications. .
  - E. **BACnet/BACnet Standard:** BACnet communication requirements as defined by ASHRAE/ANSI 135-2016.
  - F. **BACnet Interoperability Building Blocks (BIBB):** A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device in a specification.
  - G. **BACnet Broadcast Management Device (BBMD):** BACnet/IP Broadcast Management Device. The method used by BACnet for handling broadcast messages over IP (which does not support broadcasting). The approach involves the use of one BACnet/IP device per IP segment to maintain a Broadcast Distribution Table (BDT) listing all other BACnet devices on that network segment. This allows a multi-cast message sent over IP (to each BBMD) to be in turn broadcasted to all other devices on each BACnet/IP segment.
  - H. **Building Automation System (BAS):** The entire integrated management and control system
  - I. **Binding:** In the general sense, binding refers to the associations or mappings of the sources network variable and their intended or required destinations.
  - J. **Building Controller (BC):** A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control (DDC) of specific systems, acting as a communications router between the LAN backbone and sub-LANs, and data storage for trend information, time schedules, and alarm data.
  - K. **Change of Value (COV):** An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135-2016).
  - L. **Client:** A device that is the requestor of services from a server. A client device makes requests of and receives responses from a server device.
  - M. **Continuous Monitoring:** A sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).
  - N. **Controller or Control Unit (CU):** Intelligent stand-alone control panel. Controller is a generic reference and shall include BCs, AACs, and ASCs as appropriate.
  - O. **Control Systems Server (CSS):** This shall be a computer (or computers) that maintains the systems configuration and programming database.

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- P. **Direct Digital Control (DDC):** Microprocessor-based control including Analog/Digital conversion and program logic
- Q. **Enterprise Buildings Integrator (EBI):** An Enterprise-level, Intranet-based network connecting multiple buildings on USC's campus with a central data warehouse and server, accessible via the host computer.
- R. **Functional Profile:** A collection of variables required to define a the key parameters for a standard application. As this applies to the HVAC industry, this would include applications like VAV terminal, fan coil units, and the like.
- S. **Gateway (GTWY):** A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them (ASHRAE/ANSI 135-2016).
- T. **Hand Held Device (HHD):** Manufacturer's microprocessor based device for direct connection to a Controller.
- U. **Host-Based Controller:** A term applicable only to Lon-based controllers where the on-board Neuron chip is used solely as the Communications Interface and a processor independent from the Neuron chip to is used to execute Application control and I/O processes.
- V. **IT LAN:** Reference to the facility's Information Technology network, used for normal business-related e-mail and Internet communication.
- W. **LAN Interface Device (LANID):** Device or function used to facilitate communication and sharing of data throughout the BAS
- X. **Local Area Network (LAN):** General term for a network segment within the architecture. Various types and functions of LANs are defined herein.
- Y. **Local Supervisory LAN:** Ethernet-based LAN connecting Primary Controller LANs with each other and OWSs, POTs and CSSs and the LAN to which the EBI will be interfaced. See System Architecture below. **THIS CAN BE THE PRIMARY LAN.**
- Z. **Master-Slave/Token Passing (MS/TP):** Data link protocol as defined by the BACnet standard. (ASHRAE/ANSI 135-2016).
- AA. **ModBus:** A master/slave protocol (i.e., all data must be "read") that can be used over serial (EIA-232), EIA-485 (i.e. Modbus-RTU or 485), and IP (i.e., Modbus-TCP) connections. It was developed by the Modicon Corporation and is managed by the Modbus Organization, but has not been codified as a standard.
- BB. **Open Database Connectivity (ODBC):** An open standard application-programming interface (API) for accessing a database developed. ODBC compliant systems make it possible to access any data from any application, regardless of which database management system (DBMS) is handling the data.
- CC. **Operator Interface (OI):** A device used by the operator to manage the BAS including OWSs, POTs, and HHDs.



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- DD. **Operator Workstation (OWS):** The user's interface with the BAS. As the BAS network devices are stand-alone, the OWS is not required for communications to occur.
- EE. **Point-to-Point (PTP):** Serial communication as defined in the BACnet standard.
- FF. **Portable Operators Terminal (POT):** The user's interface with the BAS. As the BAS network devices are stand-alone, the POT is not required for communications to occur. Laptop PC to be used for direct connection to a controller, remote dial up connection and as the operator workstation.
- GG. **Protocol Implementation Conformance Statement (PICS):** A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device (ASHRAE/ANSI 135-2016).
- HH. **Primary Controlling LAN:** High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.
- II. **Router:** A device that connects two or more networks at the network layer.
- JJ. **Secondary Controlling LAN:** LAN connecting AACs and ASCs, generally lower speed and less reliable than the Primary Controlling LAN. Refer to System Architecture below.
- KK. **Server:** A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.
- LL. **SQL:** Standardized Query Language, a standardized means for requesting information from a database.
- MM. **Smart Device:** A control I/O device such as a sensor or actuator that can directly communicate with the controller network to which it is connected. This differs from an ASC in that it typically deals only with one variable.
- NN. **Standard Network Variable Type (SNVT):** A form of APDU specifically used to bind LonWorks control data across a LonWorks network.
- OO. **University of Southern California (USC):** Owner of the facility.
- PP. **USC Ethernet:** Reference to the facility's Information Technology network, used for normal business-related e-mail and Internet communication. Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser.
- QQ. **XIF File:** A file indicating the interface specifications for LonMark devices.
- RR. **XML (Extensible Markup Language):** A specification developed by the World Wide Web Consortium. XML is a pared-down version of SGML, designed especially for Web documents. It allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.

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## 1.08 FUNCTIONAL INTENT

- A. Throughout Sections 23 0900 through 23 0905, the Sequences of Operation, and Section 23 0801 detailed requirements are specified, some of which indicate a means, method or configuration acceptable to meet that requirement. Contractor may submit products that utilize alternate means, methods, and configurations that meet the functional intent. However these will only be allowed with prior approval by the University..

## 1.09 SUBMITTALS

- A. Submit under provisions of Section *{Insert Appropriate Section Number}*.
- B. **Electronic Submittals:** While all requirements for hard copy submittal apply, control submittals, and O&M information shall also be provided in electronic format as follows.
1. **Drawings and Diagrams:** Shop drawings shall be provided on electronic media as an [AutoCAD 2014 or later version drawing file] , Microsoft Word and/or Adobe Portable Document Format file. All 'x reference' and font files must be provided with AutoCAD files
  2. **Graphics:** All graphics shall be provided electronically adhering to USC EMS Control Graphics Standards and be directly incorporable into the selected USC EMS Enterprise software of EBI.
  3. **Other Submittals:** All other submittals shall be provided in Adobe Portable Document Format
- C. **Qualifications:** Manufacturer, Installer, and Key personnel qualifications as indicated for the appropriate item above.
- D. **Product Data:** Submit manufacturer's technical product data for each control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also include installation and start-up instructions.
- E. **Shop Drawings:** Submit shop drawings for each control system, including a complete drawing for each air handling unit, system, pump, device, etc. with all point descriptors, addresses and point names indicated. Each shop drawing shall contain the following information:
1. System Architecture and System Layout:
    - a) One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. For LonTalk systems indicate all LonTalk nodes, including Neuron ID and domain, sub-network and channel addresses. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the diagram.

- b) Provide floor plans on [[AutoCAD 2014 or later version drawing file](#)] software locating all control units, workstations, servers, LAN interface devices, gateways, etc. Include all WAN and LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. For LonTalk systems provide as-built network architecture drawings showing all LonTalk nodes, including Neuron ID and domain, sub-network and channel addresses. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.
2. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include verbal description of sequence of operation.
  3. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.
  4. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). See Section 23 0905 - Part III for additional requirements.
  5. Label each control device with setting or adjustable range of control.
  6. Label each input and output with the appropriate range.
  7. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.
  8. With each schematic, provide valve and actuator information including size, Cv, design flow, design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal positions of spring return valves and dampers.
  9. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring, which are existing, factory-installed and portions to be field-installed.
  10. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.
  11. Sheets shall be consecutively numbered.
  12. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.
  13. Table of Contents listing sheet titles and sheet numbers.

14. Legend and list of abbreviations.
15. Memory allocation projections.
16. Submit along with shop drawings but under separate cover calculated and guaranteed system response times of the most heavily loaded LAN in the system.

F. **Open Protocol Information**

1. LonWorks Systems (Any system using LonWorks shall include the following):
  - a) Binding table indicating all Network Variables used in the project, Neuron ID and domain, subnet and channel address, and associated bound variables. Clearly indicate which parameters of a functional profile are bound and can be overridden.
  - b) A point binding diagram shall be provided with each control schematic depicting all bound network variables along with the associated functional profiles.
  - c) LonMark functional profile certifications.
  - d) For Host-Based Controllers: Controller programming and configuration tool and or plug in required for all controllers with a minimum of 3 licenses as applicable.
  - e) For non-host Controllers: LonTalk Neuron C source code and/or Neuron C application programming interface tool (3 licenses) and associated files required for all controllers.
  - f) Backup of systems configuration database on CD. This shall be provided at substantial completion and at the end of the warranty period.
  - g) Documentation of all explicit messaging.
  - h) XIF files for all LonMark components.
2. BACnet Systems (Any system using BACnet shall include the following):
  - a) BACnet communication parameters such as device ID, UDP port, and network number shall be provided by USC FMS at programmers request.
  - b) BACnet object description, object ID , for each I/O point provided by vendor.
  - c) Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.
  - d) Submit PICS indicating the BACnet functionality and configuration of each controller.

- G. **EBI Interface Information:** Provide a Points List in both hard copy and in electronic format (ODBC compliant). The Points List shall contain a listing of building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID or node number, object ID (object type, instance number).

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- H. **Graphics:** Provide a complete set of control graphics for the building following USC Control Graphics Standards which will seamlessly incorporate into the EBI front end.
- I. **Framed Control Drawings:** Laminated control drawings including system control schematics, sequences of operation and panel termination drawings, shall be provided in panels for major pieces of equipment. Terminal unit drawings shall be located in the central plant equipment panel or mechanical room panel.
- J. **Control Logic Documentation**
1. Submit control logic program listings (for graphical programming) and logic flow charts illustrating (for line type programs) to document the control software of all control units.
  2. Control logic shall be annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow an operator to relate each program component (block or line) to corresponding portions of the specified Sequence of Operation.
  3. Include written description of each control sequence.
  4. Include control response, settings, setpoints, throttling ranges, gains, reset schedules, adjustable parameters and limits.
  5. Sheets shall be consecutively numbered.
  6. Each sheet shall have a title indicating the controller designations and the HVAC system controlled.
  7. Include Table of Contents listing sheet titles and sheet numbers
  8. Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation. This set will count toward the required number of Operation and Maintenance materials specified below and in Section *{Insert Appropriate Section Number}*.
- K. **Operation and Maintenance Materials:**
1. Submit documents under provisions of Section *{Insert Appropriate Section Number}*. One copy of the materials shall be delivered directly to the University's facilities operation staff, in addition to the copies required by other Sections.
  2. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
  3. Submit BAS User's Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.
  4. Submit BAS advanced Programming Manuals for each controller type and for all workstation software.
  5. Include all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Division 1.
- L. Controls contractor shall provide USC with all product line technical manuals and technical bulletins, to include new and upgraded products, by the same distribution

channel as to dealers or branches. This service will be provided for 5 years as part of the contract price, and will be offered to USC thereafter for the same price as to a dealer or branch.

- M. Manufacturers Certificates: For all listed and/or labeled products, provide certificate of conformance. Include all LonMark or BACnet functional profiles certifications for systems used on this project.
- N. Product Warranty Certificates: submit manufacturers product warranty certificates covering the hardware provided.

#### **1.10 PROJECT RECORD DOCUMENTS**

- A. Submit documents under provisions of Section *{Insert Appropriate Section Number}*.
- B. Record copies of product data and control shop drawings updated to reflect the final installed condition.
- C. Record copies of approved control logic programming and database on paper and in electronic format.. Accurately record actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of shop drawings and including changes to programs made during specified testing.
- D. Record copies of approved project specific graphic software in electronic format..
- E. For LonTalk systems provide as-built network architecture drawings showing all LonTalk nodes, including Neuron ID and domain, sub-network and channel addresses. For BACnet systems provide as-built network architecture drawings showing all BACnet nodes including a description field with specific controller identification, description and location information.
- F. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, MAC address and drawing reference number.
- G. Provide riser diagram showing the location of all controllers.
- H. Maintain project record documents throughout the warranty period and submit final documents at the end of the warranty period

#### **1.11 SYSTEM ARCHITECTURE**

- A. The system provided shall incorporate hardware resources sufficient to meet the functional requirements of these Specifications. The Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.

- B. The system shall be configured as a distributed processing network(s) capable of expansion as specified below.

*The BAS will operate on a shared Ethernet LAN including the building's IT LAN.*

- C. The system architecture shall consist of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) or multi-levelled LANs that support BCs, AACs, ASCs, Operator Workstations (OWS), Portable Operators Terminal (POT), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the BAS structure.

*This is the place where the Level 3 interoperability is specified. It should describe the options for connecting the local LAN to the EBI as part of the EBI integration part of this scope.*

1. **Enterprise Building Integrator WAN:** Intranet-based network connecting multiple buildings with a central data warehouse and server. This is an existing infrastructure and contractor is required to connect to this WAN. Contractor is required to provide BACnet Objects and services and/or LonMark Objects at the Local Supervisory LAN via BACnet or LonTalk over IP. This Ethernet LAN will be connected to the WAN to manage the exchange of data and alarms with the EBI Server including, but not limited to, trends, alarms, schedules, parameters, variables, and real time data from the local system. If the Local Supervisory LAN does not inherently use BACnet, LonTalk over IP Contractor shall provide a gateway(s), routers, hardware, software, etc. necessary to translate and facilitate services from the local protocol to the EBI. Refer to Section 23 0904 for requirements:
2. **Local Supervisory LAN:** The Local Supervisory LAN shall be an Ethernet-based, 100 Mbps LAN connecting Primary Control LANs and OWS/POTs. The LAN serves as the inter-BC gateway and OWS-to-BC gateway and communications path and as the connection point for the EBI. Contractor shall provide this as a dedicated LAN for the control system. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 5 cable with switches and routers that support 100 Mbps or higher throughput. Power-line carrier communication shall not be acceptable for communications. The higher level layers of this network shall be one of the following at Contractor's option:
  - a) **BACnet Supervisory LAN:** BACnet/IP as defined in Addendum A (Annex J) of the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in BACnet. Point/Object naming conventions are specified in 23 0905 - Part III.
  - b) **LonWorks Supervisory LAN:** Individual Primary control LonTalk Networks routed over IP using LonTalk to IP routers such as I-Lon, Coactive or equivalent. Point/Object naming conventions are specified in 23 0905 - Part III.
3. **Primary Controller LAN ('Primary LAN'):** High-speed, peer-to-peer communicating LAN used to connect AACs, ASCs and Building Controllers (BCs) and communicate exclusively control information. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending and other requirements as specified in Section 23 0903. Acceptable technologies include:
  - a) Ethernet (IEEE802.3)

- b) ARCNET (IEEE802.4)

*The following allows LonWorks Networks but specifically restricts the application to a 78 kbps Free Topology platform. This is to be required for maximum 'interchangeability'. A LonTalk LAN is considered a Primary Controller LAN.*

- c) LonTalk: The LonTalk standalone BAS shall be comprised of a network of AACs and ASCs, supporting LonTalk protocol (EIA 709.1) and twisted pair, free topology (TP/FT-10) transceivers (EIA 709.3). The secondary network shall communicate at 78 kbps. Each secondary TP/FT-10 network may support up to 64 communicating LonTalk devices without segmentation subject to the requirements for response time, trending and bandwidth utilization.
- d) Proprietary: Manufacturer's proprietary protocol.

*Most systems use a tiered LAN architecture to accomplish the control network. Lower level devices are connected to a lower powered network. This is not applicable to a LonTalk network as it is all peer-to-peer relatively high speed, however it can be segmented by routers.*

- 4. **Secondary Controller LAN ('Secondary LAN')**: Network used to connect AACs, or ASCs. These can be Master Slave/ Token Passing or polling, in addition to those allowed for Primary Controller LANs. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending requirements.

- D. **Dynamic Data Access**: Any data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS/POT, whether directly connected or connected remotely.

*Coordinate the following with the needs of the facility. The browser-based requirement will limit systems available but that list is dwindling as most manufacturers are providing some form of browser-based access.*

- E. **Remote Data Access**: The system shall support the following methods of remote access to the building data.
  - 1. **Browser-based access**: A remote user using a standard browser shall be able access all control system facilities and graphics with proper password. USC shall provide the required internet connection. The following paradigms are acceptable for browser-based access:
    - a) Native Internet-based user interfaces (HTML, Java, XML, etc.) that do not require a plug-in. The user interface must be compatible with the most current stable version of the supporting software (Java, etc.) without requiring the user to downgrade to a lesser version. .
- F. The communication speed between the controllers, LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with shop drawings including calculations to support the guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall reconfigure LAN as necessary to accomplish these performance requirements.:



1. 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at the EBI workstation.
  2. 10 seconds between a Level 2 alarm occurrence and enunciation at the EBI workstation.
  3. 20 seconds between and a Level 3-5 alarm occurrence and enunciation at the EBI workstation.
  4. 10 seconds between an operator command via the EBI workstation to change a setpoint and the subsequent change in the controller.
  5. 5 seconds between an operator command via the EBI workstation to start/stop a device and the subsequent command to be received at the controller.
  6. 10 seconds between a change of value or state of an input and it being updated on the EBI workstation.
  7. 10 seconds between an operator selection of a graphic and it completely painting the screen and updating at least 10 points.
- G. **Operator Workstation (OWS) or PORTABLE OPERATOR TERMINAL (POT):** This shall be a computer (or computers) that maintain the systems configuration and programming database. It shall be integrated with the existing EBI system. It shall hold the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers. It shall also act as a control information server to non-control system based programs, and shall be located at the building or buildings being controlled. It shall allow secure multiple-access to the control information. Refer to Section 23 0902 - BAS Operator Interfaces for its requirements.
- H. The Operator Interface shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, and remote monitoring. Refer to Section 23 0902 – BAS Operator Interfaces.
- I. The BCs, AACs, ASCs, shall monitor, control, and provide the field interface for all points specified. Each BC, AAC, or ASC shall be capable of performing all specified energy management functions, and all DDC functions, independent of other BCs, AACs, or ASCs and operator interface devices as more fully specified in Section 23 0903 - BAS Field Panels.
- J. **Systems Configuration Database:** The system architecture shall support maintaining the systems configuration database on a server or workstation on the Local Supervisory LAN. User tools provided to the University shall allow configuring, updating, maintaining, etc. current configurations and settings whether they are initiated at the server or the end device.
1. Database Schema shall be published and provided to the University to facilitate easy access to the data.
  2. Database shall be ODBC compliant or a data access driver shall be provided to act as an ODBC or OLE DB data provider.

*The following is very crucial to the level of 'systems integrator independence'. Most third-party LonWorks configuration and management tools create/work from the LNS format (two*

*tier client/server). Older LonWorks systems use a single tier 'API' database. Some popular tools do not even use any LonWorks standard for the configuration database. The following will eliminate those that do not use LNS.*

3. For LonWorks systems the SCD and associated network services shall be LonWorks Network Services (LNS) (latest version) compliant. The Network Management Application shall be LonMaker™ for Windows (latest released version) service tool (including hardware, software and any peripheral devices required) and is to be used for commissioning and management of the LonTalk control architecture. The network management service tool shall remain on the project as the property of the University. A copy of the LonTalk network database shall be archived on the service tool, documenting system bindings and node addressing. In addition all system variables shall have a plain English language description for each variable. This service tool shall be used for all system maintenance and expansion, so that the network database backup remains current
- K. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted.
- L. All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.
- M. Anytime any controller's database or program is changed in the field, the controller shall be capable of automatically uploading the new data to the CSS.

#### **1.12 WARRANTY MAINTENANCE**

- A. Contractor shall warrant all products and labor for a period of *{Insert warranty period}* after Final Acceptance.
- B. The University reserves the right to make changes to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by the University, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS. Any disagreement between the University and the Contractor on such matters shall be subject to resolution through the contract 'Disputes' clause.
- C. At no cost to the University, during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:
  1. Maintenance services shall be provided for all devices and hardware specified in sections 23 0901 through *{Insert Additional Specification Sections as applicable}*. Service all equipment per the manufacturer's recommendations. All devices shall be calibrated within the last month of the warranty period.

*The following requirements are very lax and would pertain to a non- critical office building. AE shall edit these as applicable to a given project.*

2. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by the University to the Contractor.
  - a) Response by telephone to any request for service shall be provided within two (2) hours of the University's initial telephone request for service.
  - b) In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the University's site within eight (8) hours of the University's initial telephone request for such services, as specified.
3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by the University to the Contractor.
  - a) Response by telephone to any request for service shall be provided within eight (8) working hours (contractor specified 40 hr per week normal working period) of the University's initial telephone request for service.
  - b) In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the University's site within three (3) working days of the University's initial telephone request for such services, as specified.
4. University's Telephonic Request for Service: Contractor shall specify a maximum of three telephone numbers for the University to call in the event of a need for service. At least one of the lines shall be attended at any given time. Alternatively, pagers can be used for technicians trained in system to be serviced. One of the three paged technicians shall respond to every call within 15 minutes.
5. Technical Support: Contractor shall provide technical support by telephone throughout the warranty period.
6. Preventive maintenance shall be provided throughout the warranty period in accordance with the hardware component manufacturer's requirements by fully qualified hardware and software technicians. **USC FMS shall be contacted when any technician is performing service on site.**

### 1.13 DELIVERY, STORAGE, AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

## 1.14 LISTING AND LABELING

- A. The BAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.

***NOTE:*** *The following should only be included when it is applicable, namely when the system is part of an engineered smoke control system or where the system will be specified to provide the firemen's override panel in the Fire Command Center which is typical for a high rise building. Smoke control and fire alarm systems should be segregated from the BAS in any new installations. Note that the listing may not be available with many BACnet and LonWorks products; in cases of retrofits where the system must perform smoke control functions, permitting a gateway to a proprietary system which has this listing may be necessitated. Modify the applicability of this listing as appropriate.*

- B. The BAS shall be listed by Underwriters Laboratories (UUKL 864) for supervised smoke control.

## PART II. PRODUCTS

### 2.01 MATERIALS AND EQUIPMENT

- A. Materials shall be new, the best of their respective kinds without imperfections or blemishes and shall not be damaged in any way. Used equipment shall not be used in any way for the permanent installation except where drawings or specs specifically allow existing materials to remain in place.

### 2.02 UNIFORMITY

- A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer

## **PART III. EXECUTION**

### **3.01 INSPECTION**

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### **3.02 INSTALLATION OF CONTROL SYSTEMS**

- A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
- B. Refer to additional requirements in other sections of this specification.

*Digital control stations should specifically be shown on the drawings. You should select appropriate wall/floor locations that minimize wire and tube runs and coordinate these locations with other disciplines. If the project is a control renovation, locate spare breakers in a power panel where the control contractor can obtain 120V power and show it on the floor plans*

### **3.03 DIGITAL CONTROL STATIONS , CONTROLLER QUANTITY AND LOCATION**

*AE shall designate locations for control stations and specifically reserve wall/floor space and indicate it on the drawings and coordinate it with other trades. If you are using LonPoint devices, this does not necessarily apply as the point devices may be distributed. Preferably you will have the electrical contract provide power (normal, emergency or uninterruptible as applicable) and then delete the requirement for this contractor to provide the power.*

- A. Individual Digital Control Stations (DCS) are referenced to indicate allocation of points to each DCS and DCS location. Digital control stations shall consist of one or multiple controllers to meet requirements of this specification.
- B. Where a DCS is referenced, Contractor shall provide at least one (1) controller, and additional controllers as required, in sufficient quantity to meet the requirements of this Specification. Restrictions in applying controllers are specified in Section 23 0903: BAS Field Panels. This Contractor shall extend power to the DCS from an acceptable power panel. If the control contractor wishes to further distribute panels to other locations, control contractor is responsible for extending power to that location also. Furthermore, contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the project and maintain adequate clearance for maintenance access.

*The following is a critical matter for performance and functionality that is left to the discretion of the AE. The concept of 'standalone boundaries' of a given system has long been a basic principle behind the requirements for a distributed system. The advent of the Lon Smart Devices and general purpose modules blur the distinction in some people's minds. The question is whether you accept that the "Network is the Controller", which is a concept*

*at the heart of a fully-distributed LON system. If you accept that principal, you can edit this subsection to allow it accordingly and release restrictions placed on that system.*

*It is imperative for the AE to define the limits of standalone functionality as it pertains to the specific systems being installed. You may do that via the control drawings and, for instance, say that all elements of any given control schematic must be standalone (with clarifications) or you can do that in a narrative in the specification. However it is done, it is critical that this not be overlooked and that it be carefully coordinated into a practical requirement.*

- C. Contractor shall locate DCSs as referenced. It is the Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.
- D. Contractor shall provide a minimum of the following:
  - 1. One DCS (including at least one controller) in each chilled water plant mechanical room.
  - 2. One controller for each air handler located in applicable mechanical room.
  - 3. One controller shall be provided for each terminal unit unless indicated otherwise.

### **3.04 SURGE PROTECTION**

- A. The Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all BCs, AAC/ASCS operator interfaces, printers, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10% above or below measured nominal value, with no affect on hardware, software, communications, and data storage.

### **3.05 DEMOLITION AND REUSE OF EXISTING MATERIALS AND EQUIPMENT *{Include if applicable}***

*Reuse of existing controls must be carefully coordinated by the AE. What stays and goes must be clear. As applicable, expand/edit this section to indicate what is allowed for reuse. The bottom line is assumptions will generally have to be made for bidding, but final acceptance of an existing device will not occur until the contractor tests it.*

- A. Contractor shall assume that existing equipment that specifically is indicated to be reused is in good condition and is operable. Contractor, during the course of work, shall inspect these devices and determine if any devices are in need of replacement or repair. Contractor shall prepare an itemized list of suggested repairs/replacement. This repair/replacement will be at the discretion of the University and will be accomplished by expanding this contract.
- B. Existing wire, conduit, and control panel cabinets may be reused at the contractor's discretion, but only if such materials or equipment comply with the applicable specification for new materials and equipment. Such materials shall not be reused if visibly damaged or otherwise unsuitable for the intended service.
- C. Where such materials are reused, the contractor's shop drawings shall reflect the existing wiring designation. If existing labeling is illegible or otherwise does not

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comply with the applicable specification for labeling, wiring runs shall be relabeled in accordance with the requirements specified elsewhere.

- D. Existing pneumatic tubing located between the existing BAS panels and the pneumatic operators shall not be reused; however, conduit for such tubing may be reused. All other pneumatic tubing may be reused, but only if such materials comply with the applicable specification for new materials. Materials shall not be reused if visibly damaged or otherwise unsuitable for the intended service. All pneumatic tubing to be reused shall be pressure tested and all leaks shall be repaired. All reused pneumatic tubing shall be purged with dry air or nitrogen.
- E. The existing pneumatic main air supply system shall be modified as required and reused to serve existing pneumatic controls that are to remain, and shall be extended as necessary to serve new pneumatic controls. Where existing pneumatic controls are removed, main air piping shall be removed back to the point of connection to the main air supply which remains in use, and shall be capped or plugged.
- F. Existing valves and dampers and their operators shall be reused, except where noted to be removed or provided as new. Contractor shall lubricate all damper linkages of dampers being controlled under this project.
- G. Other materials and equipment not specifically mentioned herein may be reused only if specifically allowed by indications on the drawings.
- H. For HVAC systems which are indicated to receive a new BAS, all existing materials and equipment associated with the existing pneumatic controls and BAS shall be removed unless otherwise specified or indicated to remain, or unless reused in accordance with the above requirements, except for the following: 1) conduit and electrical boxes (but not wiring within conduit) may remain in place if not reused (leave a pull line); 2) inaccessible pneumatic tubing may remain in place if not reused. Existing materials and equipment to be removed shall be removed subject to the requirements in paragraph "Sequence of Work". For HVAC systems, which are not to receive a new DDC BAS, the existing pneumatic control system shall remain fully functional.

*Include the following only when applicable. Obviously this will depend on the necessity of continuous operations and this is only a template. This item will typically have to be extensively customized for each project.*

### **3.06 SEQUENCE OF WORK FOR EXISTING SYSTEMS CONVERSION**

- A. General: All work involving changeover of control functions from existing pneumatic control system to the new DDC BAS shall be performed in accordance with the following sequence in order to minimize the duration of equipment outages. The following descriptions are intended to indicate the sequence in which the work shall be performed, not to define fully the scope of the work.
- B. Install operator's terminal, peripherals, graphic software, and LAN prior to placing any equipment under the control of the new BAS.

- C. Work which requires shutting down a pump motor, fan motor, or chiller shall be considered a utility shutdown and shall be subject to the restrictions specified in Section *{Insert Appropriate Section Number}*.
- D. The following sequence applies to an individually controlled HVAC subsystem, such as an air handling unit. Only one such system shall be placed under manual control (as described below) at any given time.
1. Install controllers adjacent to (or within) existing control panel. Programming shall be complete (except for loading and debugging) prior to installation. Install all field devices, which do not require interruption of the existing control system.
  2. Install all conduit, wiring, and pneumatic tubing which does not require interruption of the existing control system.
  3. Provide temporary variable pressure type hand pumps at each pneumatically controlled output, for temporary use by University's maintenance and operation contractor personnel. Schedule this step at least 48 hours in advance with the Building Engineer.
  4. Remove existing controls including wiring, conduit, and tubing (except materials to be reused in accordance with provisions specified elsewhere) which must be removed to facilitate installation of new BAS materials and equipment.
  5. Remove existing digital control system points (if applicable). Install and calibrate remainder of new BAS materials and equipment for this subsystem. Load controller software. Connect controller(s) to LAN.
  6. Perform all field testing and calibration that does not require connection of permanent pneumatic outputs.
  7. Remove temporary hand pumps and install permanent pneumatic output connections. Place the system under the control of the new DDC/BAS equipment. Conclude field testing and submit field testing report prior to placing the next subsystem under temporary manual control. The University shall be given a password with a priority level that allows monitoring (but not control until notification of substantial completion has been approved).
  8. Remove remaining existing pneumatic and digital control system materials and equipment (except materials to be reused in accordance with provisions specified elsewhere). All existing digital controls equipment for those subsystems that have not yet been converted shall remain intact, on-line, and fully functional.
  9. Schedule work in occupied spaces 10 days in advance with the University's representative. Scheduling shall not be required for work in equipment rooms, electrical closets, and similar service areas.

### 3.07 CONTROL POWER SOURCE AND SUPPLY

*It is preferable to have the Division 26 contractor supply power to DCS locations and provide the appropriate level of power of all control system components as located by the AE. For instance, it is required to at least have emergency power (and sometimes uninterruptible power when available) at critical controllers, control system servers, routers, workstations etc. However, this section if mainly for retrofits where no Div 26 contractor applies.*



- A. Section 23 0900 Contractor shall extend all power source wiring required for operation of all equipment and devices provided under Sections 23 0900 through 23 0905 and Sequences of Operation.

*The following item will have to be customized for each system and project. The consideration is where to power controllers from. For distributed controllers that are associated with one unit, it is convenient to power them along with the system so the controller can take action based on the presence of power. However on large centralized panels, it is required to provide a reliable source of emergency power that serves the equipment being controlled and then provide for individual monitoring of the various system's power sources by the controller. The object here is to make a robust system that does not interpret power failures as device failure and therefore in some instances have to take down the unit for manual acknowledged reset. This can compromise reliability.*

- B. General requirements for obtaining power include the following:
1. Obtain power from the electrically most proximate 120v breaker emergency power panel. Connect to a dedicated breaker designated for use by the BAS only. Breaker shall be of the proper size per NEC.
  2. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and of the correct voltage to supply the controls it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls provide separate transformer
  3. Standalone Functionality: Refer to Section 23 0903.

*The AE shall carefully coordinate the training requirements with the needs of USC's facilities staff. Expansions of existing systems obviously require less training than brand new systems. The following generally outlines an on-site training session for which you always want some basic site-specific training on-site. The more advanced training may be better provided off site on a case-by-case basis. Edit to suit project.*

### **3.08 BAS START UP, COMMISSIONING AND TRAINING**

- A. Refer to Section 23 0801

### **3.09 SEQUENCE OF OPERATION**

- A. Refer to Section *{Insert applicable Specification Section}* - Sequences of Operation

END OF SECTION 23 0900

**SECTION 23 0901 - BAS BASIC MATERIALS, INTERFACE DEVICES, AND SENSORS**

*Note to the Design AE: The AE and project manager should discuss the project with USC. There is a 'Preface' document describing how to employ this and other USC controls-related Guide Specifications. The AE is instructed to consult the Preface document for guidance on the generic BACnet nature of this specification, methods for deleting non-applicable text, and the use and deletion of Editor's Note's before proceeding to customize this specification.*

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**PART I. GENERAL****1.01 SECTION INCLUDES**

- A. Pneumatic Tubing
- B. Wiring
- C. Control Valves and Actuators
- D. Control Dampers and Actuators
- E. Control Panels
- F. Sensors
- G. Flow Meter
- H. Pneumatic Control Components (Gauges, switches, relays, etc.)
- I. Electric Control Components (Switches, EP Valves, Thermostats, Relays, Smoke Detectors, etc.)
- J. Transducers
- K. Air Flow Measuring Stations
- L. Current Switches
- M. Nameplates
- N. Testing Equipment

**1.02 RELATED DOCUMENTS**

- A. Section 23 0000 – Mechanical Design Requirements
- B. Section 23 0900 – Building Automation System (BAS) General
- C. Section 23 0902 – BAS Operator Interfaces
- D. Section 23 0903 – BAS Field Panels
- E. Section 23 0904 – BAS Communications Devices
- F. Section 23 0905 – BAS Software and Programming
- G. Section 23 0993 – Sequences of Operation
- H. Section 23 0801 – BAS Commissioning

**1.03 DESCRIPTION OF WORK**

- A. Refer to Section 23 0900 for general requirements.
- B. Refer to other Division-23 sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not work of this section.

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- C. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:
1. Control wiring between field-installed controls, indicating devices, and unit control panels.
  2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
  3. Wiring associated with indicating and alarm panels (remote alarm panels) and connections to their associated field devices.
  4. All other necessary wiring for fully complete and functional control system as specified.

#### **1.04 WORK BY OTHERS**

- A. Control Valves furnished under this section shall be installed under the applicable piping section under the direction of Section 23 0901 Contractor who will be fully responsible for the proper operation of the valve.
- B. Control Dampers furnished under this section shall be installed under the applicable air distribution or air handling equipment section under the direction of Section 23 0901 Contractor who will be fully responsible for the proper operation of the damper
- C. Water Pressure Taps, Thermal Wells, Flow Switches, Flow Meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of Section 23 0901 Contractor who will be fully responsible for the proper installation and application.
- D. Controlled Equipment Power Wiring shall be furnished and installed under Division 16. Where control involves 120V control devices controlling 120V equipment, Division 16 Contractor shall extend power wiring to the equipment. Section 23 0901 Contractor shall extend it from the equipment to the control device and provide transformers as necessary to step the voltage down.

## **PART II. PRODUCTS**

*For Echelon projects, consider adding the requirement for the 'LonWorks Node' option of I/O devices. This option (when available) will typically cost around \$50-150 per node and will enable it to be hung directly off the LonTalk LAN.*

#### **2.01 MATERIALS AND EQUIPMENT**

*Edit the following to suit the project. The cost effectiveness of pneumatically driven actuators shall be assessed by the AE and the condition or addition of the control air source and distribution equipment must also be taken into consideration. .*

- A. General: Provide electronic [pneumatic,] [and] [electric] control products in sizes and capacities indicated, consisting of valves, dampers, thermostats, clocks, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in

their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

**B. Control Air Supply:** [The Contractor may reuse existing control air in buildings where pneumatic controls will be replaced.] The Contractor shall install air dryers and air filters so that all controllers and new pneumatic devices receive a clean and dry air supply.

1. The control air filters shall remove oil and solid particles from the compressed air. Provide a prefilter and a final filter. The prefilter shall be rated for 100 percent removal of all solids 1 micron and larger, 100 percent removal of liquid water, and 70 percent removal of oil aerosols with 2000 ppm maximum inlet liquid loading. The final filter shall be rated for 100 percent removal of liquid water and solids larger than 0.03 micron; 99.999 percent removal of oil aerosols with 100 ppm maximum inlet liquid loading. Filters shall include replaceable filter element, differential pressure gauge, and automatic liquid drain trap. Filters shall be selected for a maximum pressure drop of 2 psig at compressor capacity. Filter bodies shall be rated for 225 psig or greater operating pressure. Transparent acrylic tube housings shall be protected by a perforated steel safety shield. Filters shall be Hankison, DelTech, Wilkerson, or Arrow Pneumatics. Substitutions shall be allowed per Division 1. Furnish one (1) spare filter element per filter.
2. For existing systems where no pneumatic tubing is subject to temperatures below 40°F and without refrigerated dryers, provide an air-cooled refrigerated dryer with flow capacity at 100 °F, 100 psig saturated entering air and 40 °F leaving dewpoint equal to or exceeding air compressor capacity. Refrigerated dryer shall be a single package unit with all necessary piping, refrigerant, controls, wiring and accessories. Dryer shall include refrigeration system, on/off switch, inlet air pressure gauge, trouble or fault contacts, and water separator with automatic drain. Refrigerant shall be R-134a. System shall be labeled by CSA or UL. Manufacturer shall be Hankison, Wilkerson, DelTech, Ingersol-Rand or Arrow Pneumatics.
3. **Main Air Piping** (between the compressors and the field control panels): Hard drawn copper tubing, ASTM B 88, Type L.
4. **Branch Air Piping** (to include main air between field control panels and field devices): Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder.
5. **Branch Air Piping:** Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

**C. Instrument Pipe and Tube**

1. **Hydronic and Instruments**
  - a) **Connection To Main Piping:** Provide ½ inch minimum size threadolet, ½” x 2 inch brass nipple, and ½” ball valve for connection to welded steel piping. Provide tee fitting for other types of piping.
  - b) **Remote Instruments:** Adapt from ball valve to specified tubing and extend to remote instruments. Provide a union or otherwise removable fitting at ball

- valve so that connection to main can be cleaned with straight rod. Where manifolds with test ports are not provided for instrument, provide tees with ¼” FPT branch with plug for use as test port. Adapt from tubing size to instrument connection.
- c) **Line Mounted Instruments:** Extend rigid piping from ball valve to instrument. Do not use close or running thread nipples. Adapt from ball valve outlet to instrument connection size. Provide a plugged tee if pipe makes 90 degree bend at outlet of valve to allow cleaning of connection to main with straight rod without removing instrument.
  - d) **Instrument Tubing:** Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; or brass compression-type fittings. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder. Tubing OD size shall be not less than the larger of ¼” or the instrument connection size.
  - e) **Rigid Piping For Line Mounted Instruments:** Schedule 40 threaded brass, with threaded brass fittings.
2. **Low Pressure Air Instrument Sensing Lines**
- a) **Connections:** Use suitable bulkhead type fitting and static sensing tip for static pressure connections. Adapt tubing to instrument connection.
  - b) **Tubing:** Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.
- D. **Communication Wiring:** All wiring shall be in accordance with National Electrical Codes and Division 26 of this specification.
- 1. Contractor shall supply all communication wiring between Building Controllers, Routers, Gateways, AAC’s, ASC’s and local and remote peripherals (e.g., operator workstations, printers, and modems).
  - 2. **Local Supervisory LAN:** For any portions of this network required under this section of the specification, contractor shall use Fiber or Category 5 of standard TIA/EIA 68 (10BaseT). Network shall be run with no splices and separate from any wiring over thirty (30) volts.
  - 3. **Primary and Secondary Controller LANs:** Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over thirty (30) volts. Shield shall be terminated and wiring shall be grounded as recommended by BC manufacturer.
- E. **Signal Wiring:** Contractor shall run all signal wiring in accordance with National Electric Codes and Division 16 of this Specification.
- 1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.

2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.
- F. **Low Voltage Analog Output Wiring:** Contractor shall run all low voltage control wiring in accordance with National Electric Codes and Division 16 of this Specification.
1. Low voltage control wiring shall be minimum 16-gauge, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.

*Edit the following as appropriate if distributed Lon Point devices are being used.*

- G. **Control Panels:** Provide control panels with suitable brackets for wall mounting for each control system. Locate panel adjacent to systems served.
1. Fabricate panels of 16-gage furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed on four sides, with hinged door and keyed lock, with manufacturer's standard shop-painted finish and color.
  2. Provide UL-listed cabinets for use with line voltage devices.
  3. Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip. Control panel shall have standard manufacturer's color.
  4. All gauges and control components shall be identified by means of nameplates.
  5. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover. All control panel conduit penetrations shall occur in the bottom of the panel or within the bottom  $\frac{1}{4}$  of each side.
  6. Complete wiring and tubing termination drawings shall be mounted in or adjacent to panel.

## 2.01 CONTROL VALVES

*Control valve sizing and selection is the initial responsibility of the AE and NOT left to the controls subcontractor. AE shall provide a valve schedule that lists the requirements of the valves for Cv, close off, temperature etc. This should be a result of analyzing the valves performance across the range of control.*

- A. **General:** Provide factory fabricated control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Control valves shall be equipped with heavy-duty actuators, and with proper close-off rating for each individual application. Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.
- B. **Plug or Cartridge-Type Globe Pattern for Water Service – 50 GPM and less:**
1. **Valve Sizing:** Where not specifically indicated on the control drawings, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping.



2. **Single Seated (Two-way) Valves:** Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections to campus systems unless otherwise scheduled on the drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on 'top-and-bottom' guided plugs.
  3. **Double Seated (Three-way) Valves:** Valves shall have linear characteristic. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on 'top-and-bottom' guided plugs.
  4. **Temperature Rating:** 36°F minimum, 230°F maximum
  5. **Body:** Bronze or Brass body, screwed, 235 psi maximum working pressure for 1/2" to 2"; Cast Iron, flanged, 125 psi maximum working pressure for 2-1/2" and larger.
  6. **Valve Trim:** Bronze or brass; Stem: Polished stainless steel.
  7. **Packing:** Spring Loaded Teflon or Synthetic Elastomer U-cups, self-adjusting.
  8. **Plug or Cartridge:** Brass, bronze or stainless steel, Seat: Brass
  9. **Disc:** Replaceable Composition or Stainless Steel Filled PTFE.
  10. **Ambient Operating Temperature Limits:** -32 to 122°F (0 to 50 °C)
  11. **Acceptable Manufacturers:** Subject to compliance with requirements approved manufacturers are as follows:
    - a) Honeywell
    - b) Invensys
    - c) Warren
    - d) Delta
    - e) Bray
- C. **Temperature Control Valves for Heating & Cooling Coils – All Flowrates:**
1. Valves shall be pressure independent control valves (PICV) and shall be used for all temperature control water service unless noted otherwise. The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations across the valve in the selected operating range. The control valves shall accurately control the flow from 0 to 100% full rated flow. A flow tag, furnished with each valve shall list flows at all the valve positions in 10 degrees rotation increments. A maximum of 5 psi shall be required to operate the valve pressure independently.
  2. **Rangeability:** The valves shall have a turndown capability of at least 100:1.
  3. **Body:** Bronze, flanged, 125 psi maximum working pressure.
  4. **Operating Temperature:** 250°F
  5. **Pressure/Temperature ports (Pete's Plugs):** Taps shall be installed at the factory in each valve to measure the pressure drop through the valves to determine the valve flow rate.
  6. **Acceptable Manufacturers:** Subject to compliance with requirements approved manufacturers are as follows:
    - a) >50 GPM Applications:

- 1) Delta P Valve by Flow Control Industries, Inc.
- b) <50 GPM Applications:
  - 1) Honeywell PICV
  - 2) Belimo PICV

**D. Plug-Type Globe Pattern for Steam Service:**

1. **Valve Sizing:** Where valve size is not specifically indicated on the drawings, size modulating valves for applications of 15 psig or less for 80% of inlet gage pressure unless scheduled otherwise. Modulating valves for applications of greater than 15 psig shall be sized for 42% of inlet absolute pressure unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
2. **Characteristics:** Modified equal-percentage characteristics. Cage-type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
  - a) Working Temperature: 250°F minimum for saturated steam applications of 15 psig or less; 366°F minimum for saturated steam applications of greater than 15 psig up to 150 psig.
3. **Body:** Bronze, screwed, 250 psig steam working pressure for 1/2" to 2"; Cast Iron, flanged, 100 psig steam working pressure for 2-1/2" and larger for applications of 50 psig or less.
4. **Valve Trim, Plug, Seat and Stem:** Polished stainless steel.
5. **Packing:** Spring Loaded Teflon.
6. **Disc:** Replaceable Composition or Stainless Steel Filled PTFE.
7. **Acceptable Manufacturers:** Subject to compliance with requirements approved manufacturers are as follows:
  - a) Honeywell
  - b) Invensys
  - c) Warren
  - d) Delta
  - e) Belimo

**E. Butterfly Type for Isolation:**

1. **Body:** Extended neck epoxy coated cast or ductile iron with full lug pattern, ANSI Class 125 or 250 bolt pattern to match specified flanges.
2. **Seat:** EPDM, except in loop bypass applications where seat shall be metal to metal
3. **Disc:** Bronze or stainless steel, pinned or mechanically locked to shaft
4. **Bearings:** Bronze or stainless steel
5. **Shaft:** 416 stainless steel
6. **Cold Service Pressure:** 175 psi
7. **Close Off:** Bubble-tight shutoff to 150 psi

8. **Operation:** Valve and actuator operation shall be smooth both seating and unseating. Should more than 2 psi deadband be required to seat/unseat the valve, valve shall be replaced at no cost to the Government.
9. **Acceptable Manufacturers:** Subject to compliance with requirements approved manufacturers are as follows:
  - a) Jamesbury WS815
  - b) Bray Series 31
  - c) Keystone AR2
  - d) Honeywell
  - e) Nibco

**F. Ball Type – 50 GPM and Less**

1. **Body:** Brass or bronze; one-, two-, or three-piece design; threaded ends.
2. **Seat:** Reinforced Teflon
3. **Ball:** Stainless steel.
4. **Port:** Standard or ‘V’ style.
5. **Stem:** Stainless steel, blow-out proof design, extended to match thickness of insulation.
6. **Cold Service Pressure:** 600 psi WOG
7. **Steam working Pressure:** 150 psi
8. **Acceptable Manufacturers:** Subject to compliance with requirements approved manufacturers are as follows:
  - a) Honeywell
  - b) Worcester
  - c) Nibco
  - d) Jamesbury
  - e) PBM
  - f) Delta

**G. Segmented or Characterized Ball Type - 50 GPM and Less**

1. **Body:** Carbon Steel (ASTM 216), one-piece design with wafer style ends.
2. **Seat:** Reinforced Teflon (PTFE).
3. **Ball:** Stainless steel ASTM A351
4. **Port:** Segmented design with equal-percentage characteristic.
5. **Stem:** Stainless steel.
6. **Cold Service Pressure:** 200 psi WOG
7. **Cavitation Trim:** Provide cavitation trim where indicated and/or required, designed to eliminate cavitation and noise while maintaining an equal percentage

characteristic. Trim shall be a series of plates with orifices to break the pressure drop into multi-stages.

8. **Acceptable Manufacturers:** Subject to compliance with requirements approved manufacturers are as follows:
  - a) Honeywell

## 2.02 CONTROL DAMPERS

- A. **General:** Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable air flow. Provide parallel or opposed blade dampers as recommended by manufacturers sizing techniques. For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service. Control dampers used for smoke dampers shall comply with UL 555S. Control Dampers used for fire dampers shall comply with UL 555.
- B. For general isolation and modulating control service in rectangular ducts at velocities not greater than 1500 fpm (7.62 m/s), differential pressure not greater than 2.5" w.c. (622 Pa):
  1. **Performance:** Test in accordance with AMCA 500.
  2. **Frames:** Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
  3. **Blades:** Stainless steel in lab exhausts and galvanized steel elsewhere, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts with set screws, 16 gauge minimum thickness.
  4. **Blade Seals:** Synthetic elastomer, mechanically attached, field replaceable.
  5. **Jamb Seals:** Stainless steel.
  6. **Shaft Bearings:** Oil impregnated sintered bronze, graphite impregnated nylon sleeve or other molded synthetic sleeve, with thrust washers at bearings.
  7. **Linkage:** Concealed in frame.
  8. **Linkage Bearings:** Oil impregnated sintered bronze or graphite impregnated nylon.
  9. **Leakage:** Less than one percent based on approach velocity of 1500 ft./min. (7.62 m/s) and 1 inches wg. (249Pa).
  10. **Maximum Pressure Differential:** 2.5 inches wg. (622 Pa)
  11. **Temperature Limits:** -40 to 200 °F (-40 to 93 °C).
  12. Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for installation.
- C. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6" w.c. (1493 Pa):
  1. **Performance:** Test in accordance with AMCA 500.
  2. **Frames:** Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.

3. **Blades:** extruded aluminum hollow airfoil shape, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts, 14 gauge minimum extrusion thickness.
  4. **Blade Seals:** Synthetic elastomeric, mechanically attached, field replaceable.
  5. **Jamb Seals:** Stainless steel.
  6. **Shaft Bearings:** Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless steel sleeve, with thrust washers at bearings.
  7. **Linkage:** Concealed in frame.
  8. **Linkage Bearings:** Oil impregnated sintered bronze or graphite impregnated nylon.
  9. **Leakage:** Less than 0.1 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa).
  10. **Maximum Pressure Differential:** 6 inches wg. (622 Pa)
  11. **Temperature Limits:** -40 to 200 °F (-40 to 93 °C).
12. Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts.
- D. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm, differential pressure not greater than 12" w.c.:
1. **Performance:** Test in accordance with AMCA 500.
  2. **Frames:** Galvanized steel, 12-gauge minimum thickness, welded or riveted with corner reinforcement.
  3. **Blades:** Extruded aluminum hollow airfoil shape, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 3/4 inch (19 mm) shafts with set screws
  4. **Shaft Bearings:** Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
  5. **Linkage:** 10-gauge minimum thickness galvanized steel clevis type crank arms, 3/16" x 3/4" (4.76 mm x 19 mm) minimum thickness tie rods.
  6. **Linkage Bearings:** Oil impregnated sintered bronze or graphite impregnated nylon.
  7. **Leakage:** Less than 0.2 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
  8. **Maximum Pressure Differential:** 12 inches wg. (2984 Pa)
  9. **Temperature Limits:** -40 to 300 °F (-40 to 149 °C).
  10. Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts.
- E. For general isolation and modulating control service in round ducts up to 40 inches in size at velocities not greater than 2500 fpm (12.7 m/s), differential pressure not greater than 4" w.c. (994 Pa):
1. **Performance:** Test in accordance with AMCA 500.

2. **Frames:** rolled 12 gauge steel strip for sizes 6 inch and smaller, rolled 14 gauge steel channel for larger sizes, galvanized or aluminum finish.
  3. **Blades:** Steel construction, 12 gauge minimum thickness for dampers less than 18 inches (457 mm) in size, 10 gauge minimum thickness for larger dampers.
  4. **Blade Seals:** Full circumference neoprene.
  5. **Shaft:** ½ inch (12.7 mm) diameter zinc or cadmium plated steel.
  6. **Shaft Bearings:** Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
  7. **Leakage:** Less than 0.2 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
  8. **Maximum Pressure Differential:** 4 inches wg. (994 Pa)
  9. **Temperature Limits:** -40 to 300 °F (-40 to 149 °C).
- F. For general isolation and modulating control service in round ducts up to 60 inches in size at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6" w.c. (1492 Pa):
1. **Performance:** Test in accordance with AMCA 500.
  2. **Frames:** rolled 10-gauge steel channel for sizes 48 inch and smaller, rolled 3/16 inch (4.76 mm) thick steel channel for larger sizes, galvanized or aluminum finish.
  3. **Blades:** Steel construction, 10-gauge minimum thickness for dampers not greater than 48 inches in size, ¼ inch (6.35 mm) minimum thickness for larger dampers.
  4. **Blade stops:** ½ inch x ¼ inch (12.7 mm x 6.35 mm) full circumference steel bar.
  5. **Blade Seals:** Full circumference neoprene.
  6. **Shaft:** zinc or cadmium plated steel, angle reinforcing as necessary.
  7. **Shaft Bearings:** Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
  8. **Leakage:** Less than 0.4 percent based on approach velocity of 4000 ft./min. (20.3 m/s) and 1 inches wg. (249Pa) differential pressure.
  9. **Maximum Pressure Differential:** 6 inches wg. (1492 Pa)
  10. **Temperature Limits:** -40 to 250 °F (-40 to 121 °C).

### 2.03 ACTUATORS

- A. **General:** Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.

**B. Damper Actuators**

1. Ambient Operating Temperature Limits: -10 to 150°F (-12.2 to 66 °C)
2. **Two Position Electric Actuators:** Line voltage with spring return

*Control drawings should clearly show where pneumatic Positive Positioners are required.*

3. **Pneumatic Actuators:** Provide heavy-duty actuators with stroke indication and spring return. When so indicated and where more than 2 actuators are to be operated in sequence to each other, provide position feedback positive positioners with adjustable start point and operating range. Positive Positioners shall be provided on all modulating pneumatic valves larger than 1” and as shown on drawings.
4. **Electronic Actuators:** Provide actuators with spring return for two-position (24v), 0-5 Vdc, 0-10 Vdc, 2-10Vdc, 4-20 mA, or PWM input (subject to restrictions) as required. Actuators shall travel full stroke in less than [90] seconds. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit. Where two actuators are required in parallel or in sequence, provide an auxiliary actuator driver. Actuators shall have current limiting motor protection. Actuators shall have manual override where indicated. Modulating actuators for valves shall have minimum rangeability of 40 to 1.
  - a) **Close-Off Pressure:** Provide the minimum torque required, and spring return for fail positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off pressure for two-way water valve applications shall be the shutoff head of associated pump. Required close-off rating of steam valve applications shall be design inlet steam pressure plus 50 percent for low pressure steam, and 10 percent for high pressure steam. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent.
  - b) **Acceptable Manufacturers:** Subject to compliance with requirements approved manufacturers are as follows:
    - 1) Honeywell
    - 2) Johnson Controls
    - 3) Delta
    - 4) Belimo

C. **Quarter-Turn Actuators (for ball and butterfly valves):**

1. **Electric**

- a) **Motor:** Suitable for 120 or 240 Volt single-phase power supply. Insulation shall be NEMA Class F or better. Motor shall be rated for 100 percent duty cycle. Motors shall have inherent overload protection.
- b) **Gear Train.** Motor output shall be directed to a self locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.
- c) **Wiring:** Power and control wiring shall be wired to a terminal strip in the actuator enclosure
- d) **Failsafe Positioning:** Actuators shall be spring return type for failsafe positioning.

- e) **Enclosure:** Actuator enclosure shall be NEMA-4 rated, and shall have a minimum of two threaded conduit entries. Provide an enclosure heater for actuators located outside of buildings.
  - f) **Limit Switches:** Travel limit switches shall be UL and CSA approved. Switches shall limit actuator in both open and closed positions.
  - g) **Mechanical Travel Stops:** The actuator shall include mechanical travel stops of stainless steel construction to limit actuator to specific degrees of rotation.
  - h) **Manual Override:** Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared handwheel type. For larger valves, the override shall be a fixed geared handwheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the handwheel is engaged for manual operation.
  - i) **Valve Position Indicator:** A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position.
  - j) **Torque Limit Switches:** Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.
  - k) **Position Controller:** For valves used for modulating control, provide an electronic positioner capable of accepting 4-20 mA, 0-10 Vdc, 2-10 Vdc, and 135 Ohm potentiometer.
  - l) **Ambient Conditions:** Actuator shall be designed for operation from -140 to 150 °F ambient temperature with 0 to 100 percent relative humidity.
2. **Pneumatic Single- and Double-Acting Cylinder Type:**
- a) **Air Cylinder:** Shall consist of steel or aluminum cylinder, dual pistons, double rack and pinion gearing mechanism. Housing shall be protected both internally and externally with corrosion resistant coating. Actuator shall be equipped with piston guide rods or similar mechanism so that seals are not loaded as linear bearings. Single acting units shall have multiple symmetrically arranged springs to apply equal force to piston. Cylinder shall be configurable for direction of fail-safe mode in the field. Actuators shall be spring return type for failsafe positioning.
  - b) **Position Indication:** Provide extended shaft position indicator that is removable for manual override of valve.
  - c) **Two-Position Actuators:** Provide appropriate three-way or four-way solenoid valve mounted on the actuator. Solenoid valve electrical enclosure shall meet NEMA-4 requirements. Provide actuator with position switches where required.
  - d) **Modulating Actuators:** Provide a rotary electronic positioner designed to accept 4-20 mA, 0-10 Vdc, 2-10 Vdc, or 135 Ohm potentiometer and operate integral 3-way or 4-way solenoid valve to position valve rotation angle as sensed by integral position feedback device to match signal input. Enclosure shall meet NEMA-4 requirements. Actuator linearity and resolution shall be



0.5% of span. Hysteresis and deadband shall be adjustable. Provide accessory mechanical or proximity type position switches and position transmitters where required. Actuators shall be spring return type for failsafe positioning. Provide an enclosure heater for positioners located outside of buildings.

#### 2.04 GENERAL FIELD DEVICES

- A. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.
- B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.
- C. Field devices specified herein are generally 'two-wire' type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with 'two-wire' type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide 'four-wire' type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.
- D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.
- E. **Accuracy:** As stated in this Section, accuracy shall include combined effects of nonlinearity, nonrepeatability and hysteresis.

#### 2.05 TEMPERATURE SENSORS (TS)

- A. **Sensor range:** When matched with A/D converter of BC, AAC/ASC, or SD, sensor range shall provide a resolution of no worse than 0.3°F (0.16 °C) (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25°F over 5 years.

*AE shall carefully specify other applications where matched sensors are required for the specific project.*

- B. **Matched Sensors:** The following applications shall require matched sensors:
  - 1. **Building Loop Connections:** Provide matched loop and building supply sensors where control sequence requires controlling to a temperature rise (differential).
  - 2. **Hydronic Temperature Difference Calculations:** Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations or sequencing such as across chillers and plants.

3. **Air Handling Unit Sequencing:** Provide matched pair for the cooling and heating coil leaving sensors where the sequence includes calculating an offset from the supply air setpoint to maintain a leaving heating coil temperature.

*AE must designate where various amenities to room sensors are required. The following assumes that this will be indicated on the control design drawings. Otherwise AE must add the clarification below.*

- C. **Room Temperature Sensor:** Shall be an element contained within a ventilated cover, suitable for wall mounting. Provide insulated base. Following sensing elements are acceptable:
  1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.
  2. Provide setpoint adjustment where indicated. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable via the BAS.
  3. Provide an occupancy override button on the room sensor enclosure where indicated. This shall be a momentary contact closure
  4. Provide current temperature indication via an LCD or LED readout where indicated.
- D. **Single-Point Duct Temperature Sensor:** Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 stainless steel.
  1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.2°F accuracy at calibration point

*Edit the following averaging length per square foot based on how homogeneous the air temperature will be at the installed location. For instance, a preheat sensor of a mixed air plenum will require more length than the discharge off a preheat coil in a 100% OA unit.*

- E. **Averaging Duct Temperature Sensor:** Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Temperature range as required for resolution indicated in paragraph A.
  1. Sensing element shall be platinum RTD, or thermistor, +/- 0.2°F accuracy at calibration point.
- F. **Liquid immersion temperature sensor** shall include [brass] thermowell, sensor and connection head for wiring connections. Temperature range shall be as required for resolution of 0.15°F.
  1. Sensing element (chilled water/glycol systems) shall be platinum RTD +/- 0.2°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.15°F.
  2. Sensing element (other systems) shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.3°F.

- G. **Pipe Surface-Mount Temperature Sensor:** Shall include metal junction box and clamps and shall be suitable for sensing pipe surface temperature and installation under insulation. Provide thermally conductive paste at pipe contact point. Temperature range shall be as require for resolution indicated in paragraph A.
1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.
- H. **Outside air sensors** shall consist of a sensor, sun shield, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as require for resolution indicated in Paragraph A
1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.

## 2.06 TEMPERATURE TRANSMITTERS

- A. Where required by Controller, or where wiring runs are over 50 feet, sensors as specified above may be matched with transmitters outputting 4-20 mA linearly across the specified temperature range. Transmitters shall have zero and span adjustments, an accuracy of 0.1°F when applied to the sensor range.

## 2.07 HUMIDITY TRANSMITTERS

- A. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:
1. Input Range: 0 to 100% RH.
  2. Accuracy(% RH): +/- 2% (when used for enthalpy calculation, dewpoint calculation or humidifier control) or +/- 3% (monitoring only) between 20-90% RH at 77°F, including hysteresis, linearity, and repeatability.
  3. Sensor Operating Range: As required by application
  4. Long Term Stability: Less than 1% drift per year.
- B. **Acceptable Manufacturers:** Units shall be Vaisala HM Series, General Eastern, Microline, or Hy-Cal HT Series. Substitutions shall be allowed per Division 1.

## 2.08 DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

- A. **General Purpose - Water:** Two-wire transmitter, 4-20 mA output with zero and span adjustments. Plus or minus 0.5% overall accuracy, 450 psig (3103 KPa) maximum static pressure rating, 200 psid maximum overpressure rating for 6 through 60 psid range, 450 psid for 100 through 300 psid range. Acceptable units shall be Kele & Associates Model 360 C. Substitutions shall be allowed per Division 1.
- B. **Industrial Application, Liquid, Steam and Gas:**

1. **General:** Two-wire smart DP cell type transmitter, 4-20 mA or 1-5 Vdc user-selectable linear or square root output, adjustable span and zero, stainless steel wetted parts.
  2. **Environmental limits:** -40 to 250 °F (-40 to 121°C), 0 to 100% RH..
  3. **Accuracy:** less than 0.1 percent of span.
  4. **Output Damping:** Time constant user selectable from 0 to 36 seconds.
  5. **Vibration Effect:** Less than  $\pm 0.1\%$  of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
  6. **Electrical Enclosure:** NEMA-4, -4X, -7, -9.
  7. **Approvals:** FM, CSA.
  8. **Acceptable Manufacturers:** Rosemount Inc. 3051 Series, Foxboro, Johnson-Yokagawa, Setra, or Mamac. Substitutions shall be allowed per Division 1.
- C. **General Purpose Low Pressure Air:** Generally for use in static measurement of duct pressure or constant volume air velocity pressure measurement where the range is applicable.
1. **General:** Loop powered two-wire differential capacitance cell-type transmitter.
  2. **Output:** two wire 4-20 mA output with zero adjustment.
  3. **Overall Accuracy:** Plus or minus 1%.
  4. **Minimum Range:** 0.1 in. w.c.
  5. **Maximum Range:** 10 inches w.c.
  6. **Housing:** Polymer housing suitable for surface mounting.
  7. **Acceptable Manufacturers:** Modus T30. Substitutions shall be allowed per Division 1.
  8. **Static Sensing Element:** Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
  9. **Range:** Select for specified setpoint to be between 25% and 75% full-scale.
- D. **General Purpose Low Pressure/Low Differential Air:** Generally for use in static measurement of space pressure or constant volume air velocity pressure measurement where the range is applicable.
1. **General:** Loop powered, two-wire differential capacitance cell type transmitter.
  2. **Output:** Two-wire 4-20 mA output with zero adjustment.
  3. **Overall Accuracy:** Plus or minus 1%.
  4. **Minimum Range:** 0 in. w.c.
  5. **Maximum Range:** 0.1, 0.25, or 0.5 inches w.c.
  6. **Housing:** Polymer housing suitable for surface mounting.
  7. **Acceptable Manufacturers:** Modus T30. Substitutions shall be allowed per Division 1.
  8. **Static Sensing Element:** Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
  9. **Range:** Select for specified setpoint to be between 25% and 75% full-scale.

- E. **VAV Velocity Pressure:** Generally for use in variable volume air velocity pressure measurement where the range is applicable.
1. **General:** Loop powered two-wire differential capacitance cell type transmitter.
  2. **Output:** Two-wire, 4-20 mA output with zero adjustment.
  3. **Overall Accuracy:** Plus or minus 0.25%
  4. **Minimum Range:** 0 in. w.c.
  5. **Maximum Range:** 1 inch w.c.
  6. **Housing:** Polymer housing suitable for surface mounting.
  7. **Acceptable Manufacturers:** Setra. Substitutions shall be allowed per Division 1.
  8. **Range:** Select for minimum range that will accept the maximum velocity pressure expected.

## 2.09 VALVE BYPASS FOR DIFFERENTIAL PRESSURE SENSORS

- A. Provide a five valve bypass kit for protection of DP sensors where the static on the pipe can cause an over pressure when connected to one port with the other at atmospheric pressure. Kit shall include high and low pressure isolation valves, high and low pressure vent valves, and a bypass valve contained in a NEMA-1 enclosure.

## 2.10 DIFFERENTIAL PRESSURE SWITCHES (DPS)

- A. **General Service - Air:** Diaphragm with adjustable setpoint and differential and snap acting Form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing
- B. **General Service - Water:** Diaphragm with adjustable setpoint, 2 psig or adjustable differential, and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range. 0°F to 160°F operating temperature range.

## 2.11 PRESSURE SWITCHES (PS)

- A. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150% of rated pressure.
- B. **Acceptable Manufacturers:** Square D, ITT Neo-Dyn, ASCO, Penn, Honeywell, and Johnson Controls. Substitutions shall be allowed per Division 1.

## 2.12 TRANSDUCERS

*Note that PWM transducer applications must be approved by the University. Generally these will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for slower, standard room temperature control loops. If not to be allowed, carefully delete PWM-related language from this entire paragraph accordingly.*

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- A. **Standard Capacity Electronic-to-Pneumatic (E-P) Transducers:** E-P transducers shall be Voltage-to-Pneumatic (V-P) type, Current-to-Pneumatic (I-P) type, [and Pulse Width Modulated-to-Pneumatic (PWM-P) type]:
1. **Electrical Power Supply:** 24 Vac or 24 Vdc.
  2. **Pneumatic Air Supply:** 30 psig (2.07 bar) maximum.
  3. **Air Capacity:** 1100 scim @ 20 psig (300 cm<sup>3</sup>/sec @ 1.4 bar).
  4. **Air Consumption:** Zero at steady state.
  5. **Output Span:** 0-20 psig (0-1.4 bar).
  6. **Input:** 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, or 3-15 Vdc input. [Pulse width modulated or tri-state input shall be allowed].
  7. [Pulse Width Modulated and Tri-state Input Time Base: Dip switch selectable]
  8. **Enclosure:** Polymer designed for surface or panel mount.
  9. **Air Connections:** ¼" (6.35 mm) barbed.
  10. **Failure Mode on Power Loss:** Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
  11. **Acceptable Manufacturers:** RE Technologies Model UCP-522. Substitutions shall be allowed per Division 1.
- B. **Binary to Analog Transducers ([Pulse Width Modulating] or Tri-State-to-Voltage or -Current):**
1. Adjustable zero and span.
  2. **Failure Mode on Power Loss:** Shall be provided with memory feature to allow the transducer to return to last value on power failure.
  3. **Accuracy:** ± 1% of span
  4. **Output Span:** 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10Vdc, 2-10Vdc, 0-15Vdc, 3-15Vdc
  5. **Input:** 4-20 mA, pulse width modulated or tri-state input.
  6. [Pulse Width Modulated] and Tri-state Input Time Base: Dip switch selectable.
  7. **Enclosure:** Polymer designed for surface or panel mount.
  8. **Failure Mode on Power Loss:** Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
  9. **Acceptable Manufacturers:** RE Technologies Model PWA Series. Substitutions shall be allowed per Division 1.
- C. **Electronic-to Electronic (Voltage or Current to Current or Voltage):**
1. Adjustable zero and span.
  2. **Failure Mode on Power Loss:** Memory feature to allow the transducer to return to last value on power failure.
  3. **Accuracy:** ± 1% of span.
  4. **Output Span:** 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, 3-15 Vdc.
  5. **Input:** 0-20 Vdc, 0-20 ma, 0-10 kOhm.
  6. [Pulse Width Modulated] and Tri-state Input Time Base: Dip switch selectable

7. **Enclosure:** Polymer enclosure designed for surface or panel mount.
8. **Acceptable Manufacturers:** RE Technologies Model PWA Series. Substitutions shall be allowed per Division 1.

## 2.13 CURRENT SWITCHES (CS)

- A. **Clamp-On or Solid-Core Design Current Operated Switch** (for Constant Speed Motor Status Indication)
  1. **Range:** 1.5 to 150 amps.
  2. **Trip Point:** Adjustable.
  3. **Switch:** Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
  4. **Lower Frequency Limit:** 6 Hz.
  5. **Trip Indication:** LED
  6. **Approvals:** UL, CSA
  7. **Max. Cable Size:** 350 MCM
  8. **Acceptable Manufacturers:** Veris Industries H-708/908; Inc., RE Technologies SCS1150A-LED. Substitutions shall be allowed per Division 1.
- B. **Clamp-on or Solid-Core Wire Through Current Switch (CS/CR) (for Constant Speed Motors):** Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries, Inc., Model # H938/735; or RE Technologies RCS 1150. Substitutions shall be allowed per Division 1.
  1. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX. Substitutions shall be allowed per Division 1.
- C. **Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication**
  1. **Range:** 1.5 to 135 Amps.
  2. **Trip Point:** Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
  3. **Switch:** Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
  4. **Frequency Range:** 5-75 Hz
  5. **Trip Indication:** LED
  6. **Approvals:** UL, CSA
  7. **Max. Cable Size:** 350 MCM
  8. **Acceptable Manufacturers:** Veris Industries, Inc. H-904. Substitutions shall be allowed per Division 1.
- D. **Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors):** Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac

inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable manufacturer shall be Veris Industries, Inc., Model # H934. Substitutions shall be allowed per Division 1.

- E. **Variable Speed Status:** Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

## 2.14 CURRENT TRANSFORMERS (CT)

### A. Clamp-On Design Current Transformer (for Motor Current Sensing)

1. **Range:** 1-10 amps minimum, 20-200 amps maximum
2. **Trip Point:** Adjustable
3. **Output:** 0-5 VDC.
4. **Accuracy:**  $\pm 0.2\%$  from 20 to 100 Hz.
5. **Acceptable Manufacturers:** KELE SA100. Substitutions shall be allowed per Division 1.

## 2.15 OUTDOOR AIR STATIC PRESSURE SENSING TIP

- A. **Pressure sensor:** Pressure sensing tip shall be designed to minimize the effects of wind and resulting velocity pressure up to 80 mph. Acceptable manufacturers shall be Dwyer A-306. Substitutions shall be allowed per Division 1.
- B. **Low Air Pressure Surge Dampener:** 30-second time constant. Acceptable manufacturer shall be Modus SD030. Substitutions shall be allowed per Division 1.

## 2.16 CONTINUOUS LEVEL TRANSMITTERS

### A. Capacitance Type

1. Provide a loop powered, continuous capacitance type level transmitter with adjustable span and zero.
2. **Output:** 4-20 mA.
3. **Probe:** Fluoropolymer coated stainless steel rod or cable. Provide cable probe with end attachment hardware or weight.
4. **Electrical Enclosure:** NEMA-4, -7.
5. **Approvals:** UL or CSA.
6. **Accuracy:**  $\pm 1\%$  of calibrated span.
7. **Process Connection:** MPT or ANSI Flange as required.
8. **Acceptable Manufacturers:** Drexelbrook, Endress & Hauser. Substitutions shall be allowed per Division 1.

### B. Hydrostatic Pressure



1. Two wire smart d/p cell type transmitter
2. 4-20 mA or 1 to 5 volt user selectable linear or square root output
3. Adjustable span and zero
4. Stainless steel wetted parts
5. Environmental limits: -40 to 250 °F (-40 to 121°C), 0 to 100% RH
6. Accuracy: less than 0.1 percent of span
7. Output Damping: time constant user selectable from 0 to 36 seconds
8. Vibration Effect: Less than  $\pm 0.1\%$  of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
9. Electrical Enclosure: NEMA 4, 4X, 7, 9
10. Approvals: FM, CSA
11. **Acceptable Manufacturers:** Rosemount Inc. 3051 Series, Foxboro, Kele, and Johnson-Yokogawa. Substitutions shall be allowed per Division 1.

*AE must clearly indicate which flow meters are acceptable for various duties.*

## 2.17 ULTRASONIC FLOW METERS FOR LIQUID, STEAM AND GAS SERVICE

### A. General Requirements

1. Flow meter shall be permanent multi-function dual channel completely microprocessor based utilizing the transit-time flow measurement technique. Flow meter shall use the phase detection multiple pulse transmit principle in conjunction with multiple frequency axial beam transducer technology.
2. Measured quantities include volume flow, mass flow and flow velocity.
  - a) Housing: NEMA 4X enclosure powered by 90-240 VAC, 50-60 hz
  - b) Flow Velocity Range: 0.05 to 75 fps
  - c) Output: 4-20 maDC, two 0 – to 5000 hz pulse outputs proportional to flow. Two 0-10 Vdc,
  - d) Accuracy: +/- 1% of flow over a +/- 40 fps flow range with repeatability at +/- 0.15% of flow with a flow sensitivity of 0.04 fps at any flow rate.
  - e) Inline or permanent strap-on configurations are permitted.
  - f) All wetted metal parts shall be constructed of 316 stainless steel.

B. **Acceptable Manufacturers:** Yokogawa Industrial Automation, General Electric. Substitutions shall be allowed per Division 1.

## 2.18 MAGNETIC FLOW METERS FOR WATER SERVICE

### A. **Acceptable Manufacturers:**

1. Engineering Measurements Co. (EMCO MAG 3100 with a model MAG 2500 electronic transmitter and display)
2. Rosemont
3. Toshiba
4. Hersey Measurement
5. Yokogawa Industrial Automation
6. Badger
7. Endress & Hauser

**B. General Requirements:**

1. Sensor shall be a magnetic flow meter, which utilizes Faraday's Law to measure volumetric fluid flow through a pipe.
2. The flow meter shall consist of 2 elements, the sensor and the electronics. The sensor shall generate a measuring signal proportional to the flow velocity in the pipe. The electronics shall convert this EMF into a standard current output.
3. Electronic replacement shall not affect meter accuracy (electronic units are not matched with specific sensors).
  - a) Provide a four-wire, externally powered, magnetic type flow transmitter with adjustable span and zero, integrally mounted to flow tube.
  - b) **Output:** 4-20 mA
  - c) Flow Tube: Stainless steel
  - d) **Electrical Enclosure:** NEMA 4, 7.
  - e) **Approvals:** UL or CSA.
  - f) **Stability:** 0.1% of rate over six months.
  - g) **Process Connection:** Carbon steel, ANSI 150 LB, size as required.

**C. Meter Accuracy:**

1. Under the reference conditions of a 68 °F media temperature, a 68 °F ambient temperature, a +/- 1% nominal power supply voltage, 10 diameters up stream and 5 down of straight piping and a fully developed flow profile; the meter must meet the following requirements:
2. +/- 0.8% of reading accuracy in the flow range of 1.65 - 33 ft/sec +/- (0.66/Velocity actual ft/s +0.4)% of reading accuracy in the flow range of 0-1.65 ft/sec.
3. Meter repeatability shall be +/- 0.1% of rate at velocities > 1.65 ft/sec.

**D. Calibration:** The sensor must be calibrated on an internationally accredited (i.e. NAMAS) flow rig with accuracy better than 0.1%. Calibration shall be traceable to National Institute of Standard and Technology.

**E. Construction:**

1. The meter piping material shall be AISI 304 stainless steel.
2. The meter flange and enclosure material shall be carbon steel.

3. The external surface of the sensor is to be treated with at least .006 in. (150  $\mu$ m) of Corrosion resistant two-component paint.
4. The inner meter piping shall be protected with a neoprene liner or similar liner.
5. The electrode material shall be AISI 316 Ti or better.
6. The sensor shall be ANSI class 150#.

**F. Electronics:**

1. The sensor shall contain a SENSOR-PROM, storing calibration and factory default settings, i.e. the identification of the sensor and size.
2. An ISO 9001 approved company shall manufacture the sensor and electronics.
3. As standard, the electronics must be installable directly on the sensor or installable (remote) up to 1500 ft from the sensor as a maximum.
4. With local electronics installation, the electronics shall be able to withstand 3 feet water submersion for up to 30 minutes.
5. The electronics shall be compatible with the following power specifications:
  - a) 15/230 Vac +10% to 15% 50-60 Hz.
  - b) The power consumption must be 10 Watts or less independent of meter size.
6. The meter electronics shall be able to produce simultaneous scaleable current and frequency/pulse output. The frequency output shall be linearly proportional to flow rate and scaleable from 0-10 kHz. The pulse output shall be scaleable from 50 to 5000 milliseconds duration, suitable for an electromechanical totalizer in engineering units.
7. The electronics must have an internal totalizer for summation of flow.
8. The output of the electronics must be individually, galvanically isolated with an isolation voltage of more than 500 V.

**G. Output:**

1. The current signal must be either 0-20 mA or 4-20 mA proportional to the flow velocity.
2. The output current signal must accommodate 20% over range without loss in linearity.
3. The electronics shall have an alphanumeric LCD display showing actual flow and totalized flow in engineering units.
4. The display and keyboard must be rotatable so that the display can be viewed regardless of sensor orientation.

**H. Error Detection:**

1. The electronics must be able to detect the flowing error conditions:
  - a) Signal connection between electronics and sensor interrupted.
  - b) Loss of current to the coil circuit.
  - c) Load on the current output.
  - d) Defective electronics.

- e) Defective sensor.
- f) Empty pipe.
- 2. The electronics must have an Error Log where all error conditions occurring within a period of 180 days are stored.
- I. Electronic Replacement Programming:
  - 1. The electronics must be immediately replaceable without the need of cable disconnection or renewed configuration programming.
  - 2. When the supply voltage is applied, the electronics must self configure and display flow without keyboard contact (no programming required).
  - 3. The electronics must be provided with an automatic zero flow setting.
  - 4. The electronics shall be programmable with respect to:
    - a) User display options and menu
    - b) Setting data
    - c) Configuration of outputs
    - d) Zero 'cut-off' from 0% to 9.9% of maximum flow.
  - 5. For ease of programming, the electronics shall be programmable away from the meter using the meter Sensor-Prom and a 9 V battery.
  - 6. The electronics shall be suitable for operation in an ambient temperature range of -4 °F to 120 °F.

## 2.19 VENTURI FLOW METER FOR WATER SERVICE

- 1. **Flow Sensing Element:** Differential-pressure Venturi-type designed for installation in piping.
- 2. **Construction:** Bronze or cadmium plated steel with brass quick connect fittings and attached tag with flow conversion data and rated flow. Ends shall be threaded for 2" and smaller and flanged or welded for larger than 2".
- 3. Differential transmitter shall be dual range industrial grade as specified above.
- 4. Connect differential pressure to venturi and repipe quick connect fittings for measurement. Provide ball valves to isolate quick connects and differential pressure transmitter.
- 5. Apply Venturi-type flow meters where minimum flow range is no less than 40% of maximum flow.

*AE must clearly indicate which flow meters are acceptable for various duties.*

## 2.20 AIRFLOW MEASURING STATIONS (AFMS)

- A. **Vortex Shedding Grid:** Provide an array of vortex shedding elements designed to produce stable 'Karmen Vortices' that are linear with air velocity. Provide the electronics to totalize the pulses and output average velocity proportional to an output signal of 4-20ma.

1. **Sensor Accuracy:**  $\pm 1.5\%$
  2. **Electronics Accuracy:**  $\pm 0.5\%$
  3. **Range:** Select minimum range to accommodate the expected flow range of the project
  4. **Temperature Limits:** 20-140°F
  5. **Acceptable Manufacturer:** Tek-Air Systems Inc. 'Vortek' Model. Substitutions shall be allowed per Division 1.
- B. **Fan Inlet Vortex Probe:** Provide multi-sensor probes designed to produce stable 'Karmen Vortices' that are linear with air velocity, which are installed in the inlet of the fan. Individual sensors on the probe provide frequency pulse type electronic output signals which are directly proportional and linear to airflow velocity. Provide the electronics to totalize the pulses and output average velocity proportional to an output signal of 4-20ma, 1-5 VDC or 2-10 VDC.
1. **Sensor Accuracy:**  $\pm 2\%$
  2. **Electronics Accuracy:**  $\pm 0.5\%$
  3. **Range:** Select minimum range to accommodate the expected flow range of the project
  4. **Temperature Limits:** 20-140°F
  5. **Acceptable Manufacturer:** Tek-Air Systems Inc. 'Vortek' Model VT-7000 or equal.

## 2.21 AIR VELOCITY PRESSURE SENSORS (INSERTION TYPE)

- A. **Single or Multi-Point Averaging** (as indicated): Sensing tip shall be for insertion into duct with mounting flange and push on tube connections. Material shall be suitable to the application.

## 2.22 CO<sub>2</sub> SENSORS/TRANSMITTERS (CO<sub>2</sub>)

- A. CO<sub>2</sub> sensors shall use silicon based, diffusion aspirated, infrared single beam, dual-wavelength sensor.
- B. **Accuracy:**  $\pm 36$ ppm at 800 ppm and 68°F.
- C. **Stability:** 5% over 5 years.
- D. **Output:** 4-20 mA, 0-10 Vdc or relay.
- E. **Mounting:** Duct or Wall as indicated.
- F. **Acceptable Manufacturer:** Vaisala, Inc. GMD20 (duct) or GMW20 (wall).

## 2.23 PNEUMATIC CONTROL COMPONENTS

- A. **Analog Pressure Gauges:** Gauges shall be pneumatic type, minimum 1-1/2" in (38 mm) diameter, with white face and black numerals. Surface-mounted gauges shall have chrome plated trim and be a minimum of 2-1/2" in (64 mm) diameter.

- B. **Pneumatic Actuated Pressure Switches (PE)** (for 30 psig max pressure control systems): Pressure ranges and sensitivity of PEs shall match control system sequence of operation. Switch operation shall be externally adjustable over the operating pressure range (nominal 0-20 psig, 0 to 138 KPa ). PE switches shall be SPDT type, rated for the particular application, and shall be UL listed. PE shall be as manufactured by Penn. Substitutions shall be allowed as per Division 1
- C. **Pilot Positioners:** Operating span adjustment range is from 3 to 13 psi (21 to 91 kPa). Positioner shall be furnished with a mounting bracket for attachment directly to the actuator.

## 2.24 ELECTRIC CONTROL COMPONENTS

- A. **Limit Switches (LS):** Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley. Substitutions shall be allowed per Division 1.
- B. **Electric Solenoid-Operated Pneumatic Valves (EP):** EP valves shall be rated for a minimum of 1.5 times their maximum operating static and differential pressure.. Valves shall be ported 2-way, 3-way, or 4-way and shall be normally closed or open as required by the application. EPs shall be sized for minimum pressure drop, and shall be UL and CSA listed. Furnish and install gauges on all inputs of EPs. Furnish an adjustable air pressure regulator on input side of solenoid valves serving actuators operating at greater than 30 psig.
  - 1. **Coil Enclosure:** Indoors shall be NEMA-1, Outdoors and NEMA-3, 4, 7, 9.
  - 2. **Fluid Temperature Rating:** Valves for compressed air and cold water service shall have 150 °F (66 °C) minimum rating. Valves for hot water or steam service shall have fluid temperature rating higher than the maximum expected fluid temperature.
  - 3. **Acceptable Manufacturers:** EP valves shall be as manufactured by ASCO or Parker. Substitutions shall be allowed per Division 1.
  - 4. **Coil Rating:** EP valves shall have appropriate voltage coil rated for the application (i.e., 24 VAC, 120 VAC, 24 VDC, etc.).
- C. **Low Temperature Detector ('Freezestat') (FZ):** Low temperature detector shall consist of a 'cold spot' element which responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8" x 20' (3.2mm x 6.1m), junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPST ( 4 wire, 2 circuit) with manual reset. Temperature range 15 to 55°F (-9.4 to 12.8°C), factory set at 38°F.
- D. **High Temperature Detectors ('Firestat') (FS):** High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215°F (-4 to 102°C).
- E. **Surface-Mounted Thermostat:** Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150° F (10 to 65°C) , and a minimum 10°F fixed setpoint differential.

- F. **Low Voltage Wall Thermostat:** Wall-mounted thermostat shall consist of SPDT sealed mercury contacts, operating temperature range of 50 to 90°F (10 to 32°C), switch rating of 24 Vac (30 Vac max.), and both manual and automatic fan operation in both the heat and cool modes.
- G. **Control Relays:** All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.
1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:
    - a) AC coil pull-in voltage range of +10%, -15% or nominal voltage.
    - b) Coil sealed volt-amperes (VA) not greater than four (4) VA.
    - c) Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
    - d) Pilot light indication of power-to-coil and coil retainer clips.
    - e) Coil rated for 50 and 60 Hz service.
    - f) **Acceptable Manufacturers:** Relays shall be Potter Brumfield, Model KRPA. Substitutions shall be allowed per Division 1.
  2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC. Substitutions shall be allowed per Division 1.
  3. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.
- H. **General Purpose Power Contactors:** NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1 enclosure. Manufacturer shall be Square 'D', Cutler-Hammer or Westinghouse.
- I. **Control Transformers:** Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be US and CSA listed. Primary and secondary sides shall be fused in accordance with the NEC. Transformer shall be proper size for application, and mounted in minimum NEMA-1 enclosure.
1. Transformers shall be manufactured by Westinghouse, Square 'D', or Jefferson. Substitutions shall be allowed per Division 1.
- J. **Time Delay Relays (TDR):** TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a dustproof enclosure.
1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.
  2. TDRs shall be UL and CSA listed, Crouzet type. Substitutions shall be allowed per Division 1.

- K. **Electric Push Button Switch:** Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley. Substitutions shall be allowed per Division 1.
- L. **Pilot Light:** Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley. Substitutions shall be allowed per Division 1.
- M. **Alarm Horn:** Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory. Substitutions shall be allowed per Division 1.
- N. **Electric Selector Switch (SS):** Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley. Substitutions shall be allowed per Division 1.

## 2.25 REFRIGERANT MONITOR

- A. **General:** Contractor shall provide a refrigerant sensitive infrared-based stationary refrigerant gas leak monitor system designed to continuously measure refrigerants. Refrigerant monitor shall be coordinated to detect *{insert refrigerant types here if known or delete}* refrigerants used in chiller equipment installed under Section *{Insert appropriate Section}*. The alarm system shall comply with ANSI/ASHRAE 15-1994 and local code requirements.
- B. The refrigerant monitor shall be capable of monitoring multiple refrigerant gas compounds at multiple locations in concentrations of 0 PPM to a minimum of 1000 PPM. The Monitor shall have a low range resolution of 1 PPM in the range of 1 PPM through 100 PPM. Readings above 100 PPM must be accurate to within  $\pm 5\%$  of reading. Accuracy shall be maintained within ambient environmental ranges of 0°C. through 50°C., (32°F. through 122°F.) and 5% through 90% relative humidity, non-condensing.
- C. The refrigerant monitor shall automatically and continuously monitor the areas through a sample draw type tubular pick up system with an internal pump and filter. The installation of the monitoring control and the tubing shall be in strict accordance with the manufactures instructions. The location, routing, and final position of the sample tubes shall be submitted to the engineer with all necessary shop drawings and monitor specifications and installation instructions. Tubing size, tubing material, and tube length limitations shall be within the specifications of the monitor manufacture. The location and method of tube support and hangers must be identified on the shop drawings. Each of the sampling tubes shall have end of line filters.
- D. The analyzer will be based on infrared detection technology, and will be factory tested and calibrated for the specified refrigerant or refrigerants. Factory certification of the calibrations shall be provided with the O&M manuals. . The analyzer shall provide a menu driven or automatic method of checking both zero, span calibration for each sensor, and allow for adjustment.



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- E. The monitor shall be equipped with 4 outputs. Three relays shall energize at an adjustable user defined set point based on refrigerant concentration levels. The relay threshold adjustment shall be protected by keyed or password access controls. Adjustments and observations shall be made at the front panel operator interface. The relay threshold values can be viewed without a password. The digital display will continuously display the refrigerant concentration level and alarm status. The fourth output shall indicate a monitor malfunction alarm. The monitor shall also have an analog output that will provide a linear scaled reference to the refrigerant concentration in parts per million. The analog output signal shall be an industry standard DC voltage, or mA current signal.
- F. The monitor shall have a NEMA-4 moisture resistant enclosure with a gasketed, hinged front cover. Conduits and tube connections shall be located on the bottom of the enclosure. The enclosure shall have a rust and corrosion resistant finish.
- G. The following alarm modes will be provided by the refrigerant monitor:
1. **ALARM LEVEL ONE** – Low level of refrigerant concentration at one of the sampling points has detected the presence of a possible refrigerant leak. The initial alarm threshold shall be set to 5 PPM (adj.) and increased if there are nuisance alarms. This alarm level shall be displayed on the refrigerant monitor interface panel, indicating which sensor has triggered the alarm, and the associated concentration of refrigerant in PPM. This event will also send an Alarm Level One signal to the BAS through a digital output from the monitor relay. This alarm will remain active until the refrigerant concentration is reduced below set point.
  2. **ALARM LEVEL TWO** – This alarm shall indicate that one of the sensors has detected a refrigerant concentration that is approaching dangerous levels in the area being monitored. This alarm shall be set to 25% below the maximum calculated refrigerant level specified in ANSI/ASHRAE 15-1994 and ASHRAE 34-1992. This alarm will be displayed on the monitor interface, and will indicate which of the sensors has caused the alarm, and the highest concentration in PPM. This event will also activate the beacon and audible alarm mounted on the refrigerant monitoring enclosure. This alarm will also be sent to the BAS through the digital output of the relay. In this mode the audible alarm can be silenced, but the beacon shall remain active until the fault is cleared
  3. **ALARM LEVEL THREE** – This alarm shall be set at the maximum calculated refrigerant level specified in ANSI/ASHRAE 15-1994 and ASHRAE 34-1992 whichever is the lowest concentration. The refrigerant monitor interface will display which sensor has caused the alarm, and the associated concentration in PPM. This event will also activate the beacon and audible alarm mounted on the refrigerant monitoring enclosure. If the audible alarm had been silenced by an earlier alarm, the activation of this level three alarm will cause the audible alarm to be activated again. The relay in the refrigerant monitoring panel shall activate the space ventilation system, and will disable all combustion or flame-producing equipment via hardwired control interlocks. In addition, this event will de-energize the energy source for any hot surface (850°F or 454°C) located in the space. Interlocks must also be provided to close any normally open doors or openings to the space for proper ventilation and isolation during this alarm condition. This alarm level will also signal the BAS

through the digital output through the same relay. In this mode, the audible alarm can be silenced, but the beacon shall remain active until the fault is cleared.

- H. All alarm conditions shall be report to the BAS system as follows:
  - 1. ALARM LEVEL ONE - The lowest refrigerant alarm level shall detect the presence of refrigerant in low concentrations and energize a relay to signal a low level alarm to the BAS operator terminal(s). The alarm shall display an alarm message stating that there is a potential refrigerant leak in the designated area.
  - 2. ALARM LEVEL TWO - The second refrigerant level alarm shall be a high refrigerant alarm alert. This alarm shall energize a relay to signal the BAS system indicating a high level alarm on the BAS operator terminal(s). This BAS alarm shall state that high levels of refrigerant have been detected in the designated area
  - 3. ALARM LEVEL THREE – The third refrigerant level alarm shall be a space evacuation alarm. This BAS alarm shall state that the chiller room ventilation system has been activated and combustion equipment has been disabled in the designated area.
  - 4. FAULT ALARM – Reports a high level alarm to the BAS operator terminal(s) that there is a fault in the refrigerant monitoring alarm system.
- I. Acceptable Manufacturers
  - 1 Honeywell Analytics

## 2.26 SMOKE CONTROL/FIREMAN’S OVERRIDE PANEL

- A. Integral enunciator/control panel part of complete engineered and UUKL 864 listed system.
- B. Provide clear, laminated graphic schematically representing the building air systems. Status LEDs shall be associated with graphic representations of fans. Override switches shall be provided as required by NFPA 110 to allow override of the fans and dampers applicable to the code requirements.
- C. Interface with Fire Alarm System as required to implement the requirements specified in the Sequence of Operations.

## 2.27 NAMEPLATES

- A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 thick, black, with white center core, and shall be minimum 1" x 3", with minimum 1/4" high block lettering. Nameplates for devices smaller than 1" x 3" shall be attached to adjacent surface.
- B. Each nameplate shall identify the function for each device.

## 2.28 TESTING EQUIPMENT

- A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete

test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range).

## PART III. EXECUTION

### 3.01 INSPECTION

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### 3.02 INSTALLATION OF CONTROL SYSTEMS

- A. **General:** Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of National Electric Code and all local codes.
- B. **Main Control Air Piping:** All main air piping between the compressors and the control panels shall be copper, run per ASTM B88
- C. **Branch Control Air Piping:** Accessible tubing is defined as that tubing run in mechanical equipment rooms; inside mechanical equipment enclosures, such as heating and cooling units, instrument panels; across roofs, in pipe chases, etc. Inaccessible tubing is defined as that tubing run in concrete slabs; furred walls; or ceilings with no access.
  - 1. Provide copper tubing with maximum unsupported length of 3'-0", for accessible tubing run exposed to view. Polyethylene tubing may be used in lieu of above, when run within adequately supported, rigid enclosure, such as metallic raceways, or EMT. Terminal single-line connections less than 18 in length may be copper tubing, or polyethylene tubing run inside flexible steel protection. Accessible tubing run in concealed locations, such as pipe chases, suspended ceilings with easy access, etc. may be copper or polyethylene bundled and sheathed tubing.
  - 2. Provide copper or polyethylene tubing for inaccessible tubing, other than in concrete pour. If polyethylene tubing is used, install in EMT or vinyl-jacketed polyethylene tubing.
  - 3. Polyethylene piping may be used above suspended ceiling without conduit provided it is run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tubing shall not be laid on the ceiling or duct.
  - 4. Pressure test control air piping at 30 psi (207 kPa) for 24 hours. Test fails if more than 2 psi loss occurs.
  - 5. Fasten flexible connections bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support tubing neatly.
  - 6. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

- D. **Control Wiring:** The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.
1. **Wiring System:** Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with National Electrical Code and Division 16 of this Specification. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
  2. **Control Wiring Conductors:** Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and Division 16 of this Specification.
  3. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
  4. All WAN and LAN Communication wiring shield shall be terminated as recommended by controller manufacturer. All WAN and LAN Communication wiring shall be labeled with a network number, device ID at each termination and shall correspond with the WAN and LAN system architecture and floor plan submittals.
  5. Install all control wiring external to panels in electric metallic tubing or raceway. However, communication wiring, signal wiring and low voltage control wiring may be run without conduit in concealed, accessible locations if noise immunity is ensured. Contractor will be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance. Accessible locations are defined as areas inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; in accessible pipe chases with easy access, or suspended ceilings with easy access. Installation of wiring shall generally follow building lines. Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties. Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be laid on the ceiling or duct. Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking. Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.
  6. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.
- E. **Control Valves:** Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access,

valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

- F. **Freezestats:** Install freezestats in a serpentine fashion where shown on drawing. Provide one foot of element for each square foot of coil face area. Where coil face area exceeds required length of element, provide multiple devices, wired in parallel for normally open close on trip application, wired in series for normally closed, open on trip application. Adequately support with coil clips.
- G. **Averaging Temperature Sensors:** Cover no more than two square feet per linear foot of sensor length except where indicated. Generally where flow is sufficiently homogeneous/adequately mixed at sensing location, consult AE for requirements.

*AE must specifically show locations of all flow meters and design in the straight length of duct of pipe required for accurate sensors. This length must be specifically shown on the drawing.*

- H. **Airflow Measuring Stations:** Install per manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.
- I. **Fluid Flow Sensors:** Install per manufacturer's recommendations in an unobstructed straight length of pipe.
- J. **Relative Humidity Sensors:** Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.
- K. **Differential Pressure Transmitters:** Provide valve bypass arrangement to protect against over pressure damaging the transmitter.
- L. **Flow Switches:** Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.
- M. **Current Switches for Motor Status Monitoring:** Adjust so that setpoint is below minimum operating current and above motor no load current.
- N. **Supply Duct Pressure Transmitters:**
  - 1. **General:** Install pressure tips with at least 4 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration.
  - 2. **VAV System 'Down-Duct' Transmitters:** Locate pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the air system.
- O. **Cutting and Patching Insulation:** Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

**3.03 REFRIGERANT MONITOR**

- A. Install in accordance with the manufacturer's instructions. Place sensing tips in locations to maximize effectiveness.
- B. Hard wire interlocks to the emergency ventilation and shutdown of combustion devices.

END OF SECTION 23 0901

**SECTION 23 0902 - BAS OPERATOR INTERFACES**

*Note to the Design AE: The AE and project manager should discuss the project with USC. There is a 'Preface' document describing how to employ this and other USC controls-related Guide Specifications. The AE is instructed to consult the Preface document for guidance on the generic BACnet nature of this specification, methods for deleting non-applicable text, and the use and deletion of Editor's Note's before proceeding to customize this specification.*

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**PART I. GENERAL**

**1.01 SECTION INCLUDES**

- A. Operator Workstations
- B. Portable Operator Terminal
- C. Hand Held Operator Interface Devices
- D. Permanently Mounted Operator Interface Devices
- E. Printers

**1.02 RELATED DOCUMENTS**

- A. 23 0010 - Basic Mechanical Requirements.
- B. 23 0900 – Building Automation System (BAS) General (Refer to this Section also for Definitions and Abbreviations)
- C. 23 0901 – BAS Basic Materials, and Devices
- D. 23 0903 - BAS Field Panel
- E. 23 0904 - BAS Communications Devices
- F. 23 0905 - BAS Software and Programming
- G. 23 0993 - Sequences of Operation
- H. 23 0801 – BAS Commissioning



### 1.03 DESCRIPTION OF WORK

- A. Furnish and install all Operator Interfaces and Control System Servers as required for the BAS functions specified. All computers shall be warranted by the manufacturer for a period of one year after final acceptance.
- B. Refer to Section 23 0900 for general requirements.

## PART II. PRODUCTS

### 2.01 PORTABLE REMOTE WORKSTATION

- 1. Operator Workstation PC: Must meet current Windows and Honeywell EBI requirements.

*Update operating system to latest version of Windows. Edit the following as applicable.*

- B. Operating system for operator workstation shall be latest version of Microsoft Windows used by the University. Corresponding Microsoft Office is to be provided.
- C. Provide software, graphics and programming as specified in Section 23 0905.
- D. Provide additional hardware, video drivers, etc., to facilitate all control functions and software requirements specified for the building automation system.
- E. Provide all controller configuration and interface software and/or plug ins for all devices applicable. All shall be loaded and functional. Provide all required interface cables required to connect to all networks, routers, controllers, SDs etc.
- F. Workstation PC shall have the capability of changing serial port interrupt vectors and IOBASE addresses through software.
- G. Provide a data backup system with capacity to store all aspects of the system software and configuration database including control device configuration parameters, graphics, trends, programming, etc to a single removable portable device which can be moved off site.
- H. Provide network card approved by BAS manufacturer to support Supervisory LAN communications (100 Mbps Ethernet TCP/IP Minimum) for connection to the Local Supervisory LAN and network card, or LANID where connected to the Primary Controller LAN.

*It is important that the OWS be positioned on the drawings and or their location clearly defined. Edit the following as applicable.*

## PART III. EXECUTION

### 3.01 INSTALLATION

- A. Set up the workstations and printers as indicated on the drawings. Install all software and verify that the systems are fully operational. Ensure licensing is provided for all software.

- B. No license, software component, key, etc or any piece of information required to install, configure, operate, diagnose and maintain the system shall be withheld from the University.
- C. Install electronic control system Operation and Maintenance Manuals, programming guides, network configuration tools, control shop drawings etc on each OWS/POTand CSS. Provide interface or shortcuts to guide user to the appropriate information.
- D. Set up portable operator terminal and configure it as the remote workstation. Install all software and verify that the system is fully operational.
- E. Install systems and materials in accordance with manufacturer's instructions.

**END OF SECTION 23 0902**

**SECTION 23 0903 - BAS FIELD PANELS**

*Note to the Design AE: The AE and project manager should discuss the project with USC. There is a ‘Preface’ document describing how to employ this and other USC controls-related Guide Specifications. The AE is instructed to consult the Preface document for guidance on the generic BACnet nature of this specification, methods for deleting non-applicable text, and the use and deletion of Editor’s Note’s before proceeding to customize this specification.*

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**PART I. GENERAL**

**1.01 SECTION INCLUDES:**

- A. Building Controller (BC)
- B. Advance Application Specific Controller (AAC)
- C. Application Specific Controller (ASC)

**1.02 RELATED DOCUMENTS:**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Section *{Insert Applicable Specification Section}* - Basic Mechanical Requirements
- C. Section 23 0900 - Building Automation System (BAS) General – Refer to this section for definitions of terminology
- D. Section 23 0901 - BAS Basic Materials, Interface Devices, and Sensors
- E. Section 23 0902 - BAS Operator Interfaces
- F. Section 23 0904 - BAS Communications Devices
- G. Section 23 0905 - BAS Software

- H. Section 23 0993 - Sequence of Operation
- I. Section 23 0801 – BAS Commissioning

### 1.03 DESCRIPTION OF WORK:

- A. Furnish and install DDC Control units required to support specified building automation system functions.
- B. Refer to Section 23 0900 for general requirements.

## PART II. PRODUCTS

### 2.01 STAND-ALONE FUNCTIONALITY

- A. **General:** These requirements clarify the requirement for stand-alone functionality relative to packaging I/O devices with a controller. Stand-alone functionality is specified with the controller and for each Application Category specified in Part 3. This item refers to acceptable paradigms for associating the points with the processor.
- B. **Functional Boundary:** Provide controllers so that all points associated with and common to one unit or other complete system/equipment shall reside within a single control unit. The boundaries of a standalone system shall be as dictated in the contract documents. Generally systems specified for the Application Category will dictate the boundary of the standalone control functionality. See related restrictions below. When referring to the controller as pertains to the standalone functionality, reference is specifically made to the processor. One processor shall execute all the related I/O control logic via one operating system that uses a common programming and configuration tool.
- C. The following configurations are considered acceptable with reference to a controller's standalone functionality:
  - 1. Points packaged as integral to the controller such that the point configuration is listed as an essential piece of information for ordering the controller (having a unique ordering number).
  - 2. Controllers with processors and modular back planes that allow plug in point modules as an integral part of the controller.
  - 3. I/O point expander boards, plugged directly into the main controller board to expand the point capacity of the controller.
  - 4. I/O point expansion devices connected to the main controller board via wiring and as such may be remote from the controller and that communicate via a sub LAN protocol. These arrangements to be considered standalone shall have a sub LAN that is dedicated to that controller and include no other controller devices (AACs or ASCs). All wiring to interconnect the I/O expander board shall be contained the same contiguous physical enclosure.
  - 5. General purpose LonMark I/O devices racked with a processor module in the same contiguous physical enclosure. The controller shall also include its own dedicated processor module and bridge or router making the controllers LAN communication a subnet or LAN segment dedicated to that controller. The following are additional requirements of this configuration:

- a) Configuration must meet the requirements for battery back up.
  - b) If processor fails, the I/O devices shall go to their fail condition.
  - c) Contractor shall provide a network bandwidth analysis of the controller segment or subnet. The analysis shall document network bandwidth does not exceed 70% of its saturation value including during trend file upload.
  - d) Logic must provide for orderly sequencing of I/O during a power interruption and restart of program logic upon restoration of power.
  - e) Trending must be buffered in the processor or dedicated data logging module and programming must facilitate a robust uploading scheme using LonMark File Transfer Protocol and limit available bandwidth during upload.
- D. The following configurations are considered unacceptable with reference to a controller's standalone functionality:
1. General-purpose LonMark I/O devices or Smart Devices located around the unit or system.

## 2.02 BUILDING CONTROLLER (BC)

### A. General Requirements:

1. The BC(s) shall provide fully distributed control independent of the operational status of the OWSs and CSS. All necessary calculations required to achieve control shall be executed within the BC independent of any other device. All control strategies performed by the BC(s) shall be both operator definable and modifiable through the Operator Interfaces.
2. BCs shall perform overall system coordination, accept control programs, perform automated HVAC functions, control peripheral devices and perform all necessary mathematical and logical functions. BCs shall share information with the entire network of BCs and AACs/ASCs for full global control. Each controller shall permit multi-user operation from multiple workstations and portable operator terminals connected either locally or over the Primary Controller LAN. Each unit shall have its own internal RAM, non-volatile memory, microprocessor, battery backup, regulated power supply, power conditioning equipment, ports for connection of operating interface devices, and control enclosure. BCs shall be programmable from an operator workstation, portable operator's terminal, or hand held operating device. BC shall contain sufficient memory for all specified global control strategies, user defined reports and trending, communication programs, and central alarming.
3. BCs shall be connected to a controller network that qualifies as a Primary Controlling LAN.
4. All BCs shall be protected from any memory loss due to a loss of power by one or a combination of the following:
  - a) Volatile RAM shall have a battery backup using a lithium battery with a rated service life of fifty (50) hours, and a rated shelf life of at least five years. Self-diagnostic routine shall report an alarm for a low battery condition.
  - b) EEPROM, EPROM, or NOVROM non-volatile memory

5. In addition BCs may provide intelligent, standalone control of HVAC functions. Each BC may be capable of standalone direct digital operation utilizing its own processor, non-volatile memory, input/output, wiring terminal strips, A/D converters, real-time clock/calendar and voltage transient and lightning protection devices. Refer to standalone functionality specified above.
6. The BC may provide for point mix flexibility and expandability. This requirement may be met via either a family of expander boards, modular input/output configuration, or a combination thereof. Refer to stand alone functionality specified above.
7. All BC point data, algorithms and application software shall be modifiable from the Operator Workstation.
8. Each BC shall execute application programs, calculations, and commands via a microprocessor resident in the BC. The database and all application programs for each BC shall be stored in non-volatile or battery backed volatile memory within the BC and will be able to upload/download to/from the OWS/POTand/or CSS.
9. BC shall provide buffer for holding alarms, messages, trends etc.
10. Each BC shall include self-test diagnostics, which allow the BC to automatically alarm any malfunctions, or alarm conditions that exceed desired parameters as determined by programming input.
11. Each BC shall contain software to perform full DDC/PID control loops.
12. For systems requiring end-of-line resistors those resistors shall be located in the BC.
13. Input-Output Processing
  - a) Digital Outputs (DO): Outputs shall be rated for a minimum 24 Vac or Vdc, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and [a manual hand off or auto switch to allow for override]. [If these HOA switches are not provided on the main board they shall be provided via isolation relays within the control enclosure.] Each DO shall be discrete outputs from the BC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.
  - b) Analog Inputs (AI): AI shall be 0-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-20 Vdc, 0-20 mA, and 4-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the BC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 12 bits.
  - c) Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board. Software multiplexing of an AI and resistors may only be done in non-critical applications and only with prior approval of Architect/Engineer.
  - d) Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.

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- e) Electronic Analog Outputs (AO): Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog via a DO [and transducer] is acceptable only with the University's approval (Generally these will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops.). Where these are allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. Each DO shall be discrete outputs from the BC's board (multiplexing to a separate manufacturers board is unacceptable). D/A converters shall have a minimum resolution of 10 bits.
  - f) Analog Output Pneumatic (AOP), 0-20 psi: Pneumatic outputs via an I/P transducer, [PWM/P transducer], or digital to pneumatic transducer are acceptable. Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the BC and provide individual feedback. Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.
  - g) Pulsed Inputs: Capable of counting up to 8 pulses per second with buffer to accumulate pulse count. Pulses shall be counted at all times.
- 14. A communication port for operator interface through a terminal shall be provided in each BC. It shall be possible to perform all program and database back-up, system monitoring, control functions, and BC diagnostics through this port. Standalone BC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or workstations.
  - 15. Each BC shall be equipped with loop tuning algorithm for precise proportional, integral, derivative (PID) control. Loop tuning tools provided with the Operator Workstation software is acceptable. In any case, tools to support loop tuning must be provided such that P, I, and D gains are automatically calculated.
  - 16. Slope intercepts and gain adjustments shall be available on a per-point basis.
  - 17. BC Power Loss:
    - a) Upon a loss of power to any BC, the other units on the primary controlling network shall not in any way be affected.
    - b) Upon a loss of power to any BC, the battery backup shall ensure that the energy management control software, the Direct Digital Control software, the database parameters, and all other programs and data stored in the RAM are retained for a minimum of fifty (50) hours. An alarm diagnostic message shall indicate that the BC is under battery power.
    - c) Upon restoration of power within the specified battery backup period, the BC shall resume full operation without operator intervention. The BC shall automatically reset its clock such that proper operation of any time dependent function is possible without manual reset of the clock. All monitored functions shall be updated.
    - d) Should the duration of a loss of power exceed the specified battery back-up period or BC panel memory be lost for any reason, the panel shall
-

automatically report the condition (upon resumption of power) and be capable of receiving a download via the network, and connected computer. In addition, the University shall be able to upload the most current versions of all energy management control programs, Direct Digital Control programs, database parameters, and all other data and programs in the memory of each BC to the operator workstation via the local area network, or via the telephone line dial-up modem where applicable, or to the laptop PC via the local RS-232C port.

18. BC Failure:
  - a) Building Controller LAN Data Transmission Failure: BC shall continue to operate in stand-alone mode. BC shall store loss of communication alarm along with the time of the event. All control functions shall continue with the global values programmable to either last value or a specified value. Peer BCs shall recognize the loss, report alarm and reconfigure the LAN.
  - b) BC Hardware Failure: BC shall cease operation and terminate communication with other devices. All outputs shall go to their specified fail position.
19. Each BC shall be equipped with firmware resident self-diagnostics for sensors and be capable of assessing an open or shorted sensor circuit and taking an appropriate control action (close valve, damper, etc.).
20. BCs may include LAN communications interface functions for controlling secondary controlling LANs Refer to Section 23 0904 - BAS System Communications Devices for requirements if this function is packaged with the BC.
21. A minimum of four levels of password protection shall be provided at each BC.
22. BCs shall be mounted on equipment, in packaged equipment enclosures, or locking wall mounted in a NEMA 1 enclosure, as specified elsewhere.
- B. **BACnet Building Controller Requirements:** (If BACnet is used, the following apply)
  1. The BC(s) shall support all BIBBs defined in the BACnet Building Controller (B-BC) device profile as defined in the BACnet standard.
  2. BCs shall communicate over the BACnet Building Controller LAN.
  3. Each BC shall be connected to the BACnet Building Controller LAN communicating to/from other BCs.
- C. **LonTalk Building Controller Requirements:** (If LonTalk is used, the following apply)
  1. All products shall be LonMark certified, and shall be designed according to the LonMark Interoperability Guidelines. Product documentation and devices shall display the LonMark symbol, indicating conformance to the LonMark Interoperability Standards.
  2. All products shall support and be certified to an appropriate LonMark functional profile. Where published profiles do not exist, use draft profile standards or submit a proposed draft as part of the submittal package. All drafts shall also be submitted simultaneously to the LonMark Interoperability Association for certification.



3. An external interface file (\*.XIF) shall be provided for each LonTalk device describing network variables, configuration parameters and other parameters supported.
4. All products shall utilize standard configuration parameter types for all product configuration parameters. Do not use network variables for this purpose.
5. The use of manufacturer-defined network variables and configuration parameters shall be limited to factory-configured parameters. All data and configuration parameters that may be required for field installation, service and maintenance shall be represented using standard LonMark network variables and configuration parameters. Modification of LonMark certified network variables and configuration parameters is unacceptable.
6. Provide I.LON 1000 Internet Server/Routers as required to combine different secondary (TP/FT-10) networks onto the primary Ethernet/IP network, or as required to segment groups of LonTalk devices to meet minimum throughput requirements.
7. Provide all necessary I.LON 1000 Internet Server/Routers and gateways in order to connect TP/FT-10 devices to the primary network, and to connect the primary network to the EBI network.
8. The network services for the BAS shall be the latest version of Echelon LonWorks Network Services (LNS).
9. The Network Management Application shall be LonMaker™ for Windows (Latest Released Version) service tool (including hardware, software and any peripheral devices required) and is to be used for commissioning and management of the LonTalk control architecture. The network management service tool shall remain on the project as the property of the University. A copy of the LonTalk network database shall be archived on the service tool, documenting system bindings and node addressing. In addition all system variables shall have a plain English language description for each variable. This service tool shall be used for all system maintenance and expansion, so that the network database backup remains current.

### **2.03 ADVANCED APPLICATION SPECIFIC CONTROLLER (AAC) AND APPLICATION SPECIFIC CONTROLLER (ASC)**

#### **A. General Requirements:**

1. AACs and ASCs shall provide intelligent, standalone control of HVAC equipment. Each unit shall have its own internal RAM, non-volatile memory and will continue to operate all local control functions in the event of a loss of communications on the ASC LAN or sub-LAN. Refer to standalone requirements by application specified in Part 3 of this section. In addition, it shall be able to share information with every other BC and AAC /ASC on the entire network.
2. Each AAC and ASC shall include self-test diagnostics that allow the AAC /ASC to automatically relay to the BC, LAN Interface Device or workstation, any malfunctions or abnormal conditions within the AAC /ASC or alarm conditions of inputs that exceed desired parameters as determined by programming input.
3. AACs and ASCs shall include sufficient memory to perform the specific control functions required for its application and to communicate with other devices.

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4. Each AAC and ASC must be capable of stand-alone direct digital operation utilizing its own processor, non-volatile memory, input/output, minimum 8 bit A to D conversion, voltage transient and lightning protection devices. All volatile memory shall have a battery backup of at least fifty- (50) hrs with a battery life of five years.
  5. All point data; algorithms and application software within an AAC /ASC shall be modifiable from the Operator Workstation.
  6. AAC and ASC Input-Output Processing
    - a) Digital Outputs (DO): Outputs shall be rated for a minimum 24 VAC or VDC, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and [a manual hand off or auto switch to allow for override]. [If these HOA switches are not provided on the main board they shall be provided via isolation relays within the control enclosure.] Each DO shall be discrete outputs from the AAC/ASC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.
    - b) Analog Inputs (AI): AI shall be 0-5 Vdc, 0-10Vdc, 2-10 Vdc, 0-20Vdc, 0-20 mA and 4-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the BC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 8-10 bits depending on application.
    - c) Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board. Software multiplexing of an AI and resistors may only be done in non-critical applications and only with prior approval of Architect/Engineer
    - d) Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.
    - e) Electronic Analog Outputs (AO) as required by application: voltage mode, 0-5VDC and 0-10VDC; current mode (4-20 mA). Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog via a DO [and transducer] is acceptable only with the University's approval (Generally, PWM will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for standard room temperature control loops.). Where PWM is allowed, transducer/actuator shall be programmable for normally open, normally closed, or hold last position and shall allow adjustable timing. Each DO shall be discrete outputs from the BC's board (multiplexing to a separate manufacturers board is unacceptable). D/A converters shall have a minimum resolution of 8 bits.
    - f) Analog Output Pneumatic (AOP), 0-20 psi: Pneumatic outputs via an I/P transducer, PWM/P transducer, or digital to pneumatic transducer are acceptable. Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the AAC /ASC
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and provide individual feedback. Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.

**B. BACnet AAC(s) and ASC(s) Requirements:**

1. The AAC(s) and ASC(s) shall support all BIBBs defined in the BACnet Building Controller (B-AAC and B-ASC) device profile as defined in the BACnet standard.
2. AAC(s) and ASC(s) shall communicate over the BACnet Building Controller LAN or the ASC LAN or sub-LAN.
3. Each BC shall be connected to the BACnet Building Controller LAN communicating to/from other BCs.

**C. LonTalk AAC(s) and ASC(s) Requirements:**

1. Refer to LonWorks requirements under BC. All apply also to the AACs and ASCs.

**D. Terminal Box Controllers:**

1. Terminal box controllers controlling damper positions to maintain a quantity of supply or exhaust air serving a space shall have an automatically initiated function that resets the volume regulator damper to the fully closed position on a scheduled basis. The controllers shall initially be set up to perform this function once every 24 hours. The purpose of this required function is to reset and synchronize the actual damper position with the calculated damper position and to assure the damper will completely close when commanded. The software shall select scheduled boxes randomly and shall not allow more than 5% of the total quantity of controllers in a building to perform this function at the same time. When possible the controllers shall perform this function when the supply or exhaust air system is not operating or is unoccupied.

## **PART III. EXECUTION**

### **3.01 INSPECTION:**

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### **3.02 INSTALLATION OF CONTROL SYSTEMS:**

- A. General: Install systems and materials in accordance with manufacturer's instructions, specifications roughing-in drawings and details shown on drawings. Contractor shall install all controllers in accordance with manufacturer's installation procedures and practices.

### **3.03 HARDWARE APPLICATION REQUIREMENTS**

*Here is where you assert your concept of optimal mix of power/quality/cost effectiveness. There are multiple levels of controller/application defined, the higher Category numbers being more powerful and expensive. The AE defines - within each category - what system(s) must be controlled (in standalone fashion) by controllers that meet that category. This item needs specific attention on every project.*

- A. **General:** The functional intent of this specification is to allow cost effective application of manufacturers standard products while maintain the integrity and reliability of the control functions. A Building Controller as specified above is generally fully featured and customizable whereas the AAC/ASC refers to a more cost-effective unit designed for lower-end applications. Specific requirements indicated below are required for the respective application. Manufacturer may apply the most cost-effective unit that meets the requirement of that application.
- B. **Standalone Capability:** Each Control Unit shall be capable of performing the required sequence of operation for the associated equipment. All physical point data and calculated values required to accomplish the sequence of operation shall originate within the associated CU with only the exceptions enumerated below. Refer to Item 2.01 above for physical limitations of standalone functionality. Listed below are functional point data and calculated values that shall be allowed to be obtained from or stored by other CUs via LAN.
- C. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.
- D. **Application Category 0** (Distributed monitoring)
1. Applications in this category include the following:
    - a) Monitoring of variables that are not used in a control loop, sequence logic, or safety.
    2. Points on BCs, AACs, and ASCs may be used in these applications.
    3. Where these points are trended, contractor shall verify and document that the network bandwidth is acceptable for such trends and is still capable of acceptable and timely control function.
- E. **Application Category 1** (Application Specific Controller):
1. Applications in this category include the following:
    - a) Fan Coil Units
    - b) Airflow Control Boxes (VAV and Constant Volume Terminal Units)
    - c) Misc. Heaters
    - d) Unitary equipment <15 tons (Package Terminal AC Units, Package Terminal Heat Pumps, Split-System AC Units, Split-System Heat Pumps, Water-Source Heat Pumps)
    - e) Induction Units
  2. ASCs may be used in these applications.
  3. **Standalone Capability:** Provide capability to execute control functions for the application for a given setpoint or mode, which shall generally be occupied mode control. Only the following data (as applicable) may be acquired from other controllers via LANs. In the event of a loss of communications with any other controller, or any fault in any system hardware that interrupts the acquisition of any of these values, the ASC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.
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<u>Physical/Virtual Point</u>	<u>Default Value</u>
Scheduling Period	Normal
Morning Warm-Up	Off (cold discharge air)
Load Shed	Off (no shedding)
Summer/Winter	Summer
Trend Data	N/A
Smoke Pressurization Mode	Normal Mode

4. **Mounting:**

- a) ASCs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use.
- b) ASCs that control equipment mounted in a mechanical room may either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location. Equipment is to be mounted within a NEMA 12 water tight enclosure.
- c) ASCs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.
- d) Section 23 0903 contractor may furnish ASCs to the terminal unit manufacturer for factory mounting.

5. **Programmability:** Operator shall be able to modify all setpoints (temperature and airflow), scheduling parameters associated with the unit, tuning and set up parameters, interstage timing parameters, and mode settings. Application-specific block control algorithms may be used to meet the sequence of operations. The ability to customize the control algorithm is not required unless specifically indicated otherwise.

6. **LAN Restrictions:** Only Application 1 equipment listed in Item 1 above shall reside on this LAN. Limit the number of nodes servicing any one of these applications on the AAC/ASC LAN to 32.

**F. Application Category 2 (General Purpose Terminal Controller)**

1. Applications in this category include the following:

- a) Unitary Equipment  $\geq$  15 tons (Air Conditioners, Heat Pumps, Packaged Heating/Cooling Units, and the like)
- b) Small, Constant Volume Single Zone Air Handling Units
- c) Constant Volume Pump Start/Stop
- d) Variable Speed Drive (VSD) controllers not requiring safety shutdowns of the controlled device.
- e) Misc. Equipment (Exhaust Fan) Start/Stop
- f) Misc. Monitoring (not directly associated with a control sequence and where trending is not critical)

2. BCs may be used in these applications.

3. ASC's may be used in these applications provided the ASC meets all requirements specified below. This category requires a general-purpose ASC to which application-specific control algorithms can be attached.

4. **Standalone Capability:** Only the following data (as applicable) may be acquired from other ASCs via LANs. In the event of a loss of communications with any other ASCs, or any fault in any system hardware that interrupts the acquisition of any of these values, the AAC/ASC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

<u>Physical/Virtual Point</u>	<u>Default Delay Time</u>	<u>Default Value</u>
Outside Air Temperature	3 minutes	80°F
Outside Air Humidity	3 minutes	60%RH
Outside Air Enthalpy	3 minutes	30 Btu/lb
Trend Data		N/A
Cooling/Heating Requests	3 minutes	None
Smoke Pressurization Mode	3 minutes	Normal Mode
Smoke Exhaust Command	3 minutes	Normal Mode

5. **Mounting:**

- a) ASCs that control equipment located above accessible ceilings shall be mounted on the equipment and shall be rated for plenum use.
- b) ASCs that control equipment located in occupied spaces or outside shall either be mounted within the equipment enclosure (responsibility for physical fit remains with the contractor) or in a near by mechanical/utility room in which case it shall be enclosed in a NEMA 12, locking enclosure.

6. **Programmability:** Operator shall be able to modify all setpoints (temperature and airflow), scheduling parameters associated with the unit, tuning and set up parameters, interstage timing parameters, and mode settings. Operator shall be able to address and configure spare inputs for monitoring. Operator shall be able to address and configure spare outputs for simple single loop control actions or event initiated actions. Application-specific block control algorithms shall used to meet the sequence of operations. The ability to customize the control algorithm is not required unless specifically indicated otherwise.

7. **LAN Restrictions:** Only Application 2 equipment listed in Item 1 above shall reside on this LAN. Limit the number of nodes servicing any one of these applications on the AAC/ASC LAN to 16.

### G. Application Category 3

1. Applications in this category include the following:
  - a) Large Constant Volume Air Handlers (>5000 CFM) or Constant Volume Air Handlers serving critical areas
  - b) VAV Air Handlers
  - c) Dual Duct Air Handlers
  - d) Multizone Air Handlers
  - e) Self Contained VAV Units
  - f) Central Cooling Plant and all associated components
  - g) Central Heating Plant and all associated components

- h) Local Free Cooling Heat Exchanger Control
- 2. BCs shall be used in these applications.

**3.04 CONTROL UNIT REQUIREMENTS**

- A. Refer to Section 23 0900 for requirements pertaining to control unit quantity and location.

*END OF SECTION 23 0903*

**SECTION 23 0904 - BAS COMMUNICATION DEVICES**

*Note to the Design AE: The AE and project manager should discuss the project with USC. There is a ‘Preface’ document describing how to employ this and other USC controls-related Guide Specifications. The AE is instructed to consult the Preface document for guidance on the generic BACnet nature of this specification, methods for deleting non-applicable text, and the use and deletion of Editor’s Note’s before proceeding to customize this specification.*

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**PART I. GENERAL**

**1.01 SECTION INCLUDES**

- A. EBI Network Integration Devices
- B. Controller Local Area Network Interface Devices (LANID)
- C. Local Supervisory LAN Gateways/Routers
- D. Chiller Controls Interface Device (CID)

**1.02 RELATED DOCUMENTS:**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Section *{Insert Applicable Specification Section}* - Basic Mechanical Requirements
- C. Section 23 0900 – Building Automation System (BAS) General
- D. Section 23 0901 - BAS Basic Materials, Interface Devices, and Sensors
- E. Section 23 0902 - BAS Operator Interfaces
- F. Section 23 0903 - BAS Field Panels
- G. Section 23 0905 - BAS Software
- H. Section 23 0993 - Sequences of Operation



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I. Section 23 0801 – BAS Commissioning

**1.03 DESCRIPTION OF WORK**

- A. Contractor shall provide all interface devices and software to provide an integrated system connecting BCs, AACs, ASCs and Gateways to the Honeywell Enterprise Buildings Integrator (EBI) network located in the BAS Control Center.

**PART II. PRODUCTS**

**2.01 EBI NETWORK CONNECTION**

- A. **EBI WAN:** Intranet-based network connecting multiple buildings with a central data warehouse and server. This is an existing infrastructure and contractor is required to connect to this WAN. Contractor is required to provide BACnet Objects and services and/or LonMark Objects at the Local Supervisory LAN via BACnet over IP or LonTalk over IP. The contractor will connect to this Ethernet LAN to manage the exchange of data and alarms with the EBI Server including, but not limited to, trends, alarms, schedules, parameters, variables, and real time data from the local system. If the Local Supervisory LAN does not inherently use BACnet over IP or LonTalk over IP, this Contractor shall provide a gateway(s), routers, hardware, software, etc. necessary to translate and facilitate services from the local protocol to the EBI.
- B. When utilizing a BACnet Gateway the following BIBBs must be supported on the Local Supervisory LAN using Ethernet:
1. Read Property (DS-RP-A) Initiate
  2. Read Property (DS-RP-B) Execute
  3. Read Property Multiple (DS-RPM-A) Initiate
  4. Read Property Multiple (DS-RPM-B) Execute
  5. Write Property (DS-WP-A) Initiate
  6. Write Property (DS-WP-B) Execute
  7. Write Property Multiple (DS-WPM-A) Initiate
  8. Write Property Multiple (DS-WPM-B) Execute
  9. COV Unsubscribed (COVU-A) Initiate
  10. COV Unsubscribed (COVU-B) Execute
  11. Dynamic Device Binding - A (DM-DDB-A)
  12. Dynamic Object Binding – A (DM-DOB-A)
  13. DeviceCommunicationControl – A (DM-DCC-A)
  14. TimeSynchronization – A (DM-TS-A)
  15. UTCTimeSynchronization – A (DM-UTC-A)
  16. ReinitializeDevice - A (DM-RD-A)
  17. Connection Establishment - A (NM-CE-A)
  18. List Manipulation-B (DM-LM-B)
  19. Object Creation and Deletion – B (DM-OCD-B)
  20. Dynamic Device Binding - A (DM-DDB-A)
  21. Alarm and Event-Notification-A (AE-N-A)

22. Alarm and Event-ACK-A (AE-ACK-A)
  23. Alarm and Event-Summary-A (AE-ASUM-A)
  24. Bacnet Schedules
- C. When utilizing a direct LonTalk interface to the EBI the following must be supported on the Local Supervisory LAN using Ethernet:
1. All LonMark Objects and Functional Profiles
  2. All Network Variables
  3. All Configuration Properties
- D. Refer to *Section 23 0905* Part III for the BACnet Object naming convention.

## 2.02 EBI NETWORK GATEWAYS

- A. This is applicable when the Local Supervisor LAN is not BACnet over IP or LonTalk over IP. A Gateway shall be provided to link non-BACnet and non LonMark Compliant control products to the EBI. The Gateway shall include all necessary gateway(s), routers, hardware, software, etc. necessary to meet the requirements listed. All of the functionality described in this section is to be provided by using the capabilities of BACnet. Each Gateway shall have the ability to expand the number of BACnet objects of each type supported by 20% to accommodate future system changes.
- B. Each Gateway shall provide values for all points on the non-BACnet side of the Gateway to BACnet devices as if the values were originating from BACnet objects. The Gateway shall also provide a way for BACnet devices to modify (write) all points specified using standard BACnet services. All points are required to be writable for each site.
- C. The Gateway shall implement BACnet schedule objects and permit both read and write access to the schedules from the workstation.
- D. The Gateway shall provide a way to collect and archive or trend (time, value) data pairs.
- E. Each Gateway and any devices that the Gateway represents which have time of day information shall respond to workstation requests to synchronize the date and time. Each Gateway and any devices that the Gateway represents shall support dynamic device binding and dynamic object binding. Refer to the BIBBs listed above for other minimum requirements of the Gateway.
- F. All points in the system shall be made network-visible through the use of standard BACnet objects or through proprietary BACnet extensions that the workstation also supports. All points shall be writable using standard BACnet services.
- G. All devices have a Device Object instance number that is unique throughout the entire EBI network. All BACnet devices shall be configured with a Device Object instance number that is based on the format specified (shown in decimal notation). This includes all physical devices as well as any logical BACnet devices that are physically represented by gateways.

*The following is applicable to a tiered architecture that may or may not be BACnet but is definitely not applicable to Lon architectures*

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**2.03 CONTROLLER LOCAL AREA NETWORK INTERFACE DEVICES (LANID)**

- A. The Controller LANID shall be a microprocessor-based communications device which acts as a gateway/router between the Primary LAN, Secondary LAN, an operator interface, modem to support remote operator interface, or printer. These may be provided within a BC or as a separate device.
- B. The LANID shall perform information translation between the Primary LAN and the Secondary LAN, supervise communications on a polling secondary LAN, and shall be applicable to systems in which the same functionality is not provided in the BC. In systems where the LANID is a separate device, it shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply as specified for a BC in Section 23 0903. Each LANID shall be mounted in a lockable enclosure.
- C. Each LANID shall support interrogation, full control, and all utilities associated with all BCs on the Primary LAN, all AACs and ASCs connected to all secondary LANs under the Primary Controller LAN, and all points connected to those PCUs and SCUs.
- D. Upon loss of power to a LANID, the battery shall provide for minimum 100-hour backup of all programs and data in RAM. The battery shall be sealed and self-charging.
- E. The LANID shall be transparent to control functions and shall not be required to control information routing on the Primary LAN
- F. All BACnet Interoperability Building Blocks (BIBBs) are required to be supported for each native BACnet device or Gateway. The Gateway shall support all BIBBs defined in the BACnet Gateway's device profile as defined in the BACnet standard.

**2.04 LOCAL SUPERVISORY LAN GATEWAY/ROUTERS**

- A. The Supervisory Gateway shall be a microprocessor-based communications device that acts as a gateway/router between the Supervisory LAN, OWS/POT and the Primary LAN.
- B. The Gateway shall perform information translation between the Primary LAN which may be proprietary and the Local Supervisory LAN, which is 100 Mbps Ethernet TCP/IP and shall preferably use BACnet over IP. When BACnet is used, refer to the requirements of the BACnet Gateways specified herein.
- C. The gateway shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply as specified for a BC in Section 23 0903. Each gateway/router shall be mounted in a lockable enclosure unless it is a PC that also serves as an OWS/POT. .
- D. The gateway/router shall allow centralized overall system supervision, operator interface, management report generation, alarm annunciation, acquisition of trend data, and communication with control units. It shall allow system operators to perform the following functions from the OWS and POTs:
  - 1. Configure systems.
  - 2. Monitor and supervise control of all points.
  - 3. Change control setpoints.
  - 4. Override input values.
  - 5. Override output values

6. Enter programmed start/stop time schedules.
  7. View and acknowledge alarms and messages.
  8. Receive, store and display trend logs and management reports.
  9. Upload/Download programs, databases, etc. as specified.
  10. BBMD capability
- E. Upon loss of power to the Gateway, the battery shall provide for minimum 100 hour backup of all programs and data in RAM. The battery shall be sealed and self-charging.
- F. The Gateway shall be transparent to control functions and shall not be required to control information routing on the Primary LAN

## **2.05 CHILLER CONTROLS INTERFACE DEVICE (CID)**

- A. The CID shall be a microprocessor-based communications device that acts as a gateway between the control protocol and the applicable chiller controller.
- B. The CID shall contain its own microprocessor, RAM, battery, communication ports and, power supply.
- C. Each CID shall support full bi-directional communications translation as more fully specified in Section 23 0905.
- D. The following points shall be mapped as a minimum:
1. CHW Supply and Return Temperatures
  2. CW Supply and Return Temperatures
  3. Power Consumption (kW)
  4. Percent of Power Consumption (compared to maximum)
  5. Bearing Temperature
  6. Suction and Head Pressures
  7. Suction and Head Temperatures
  8. All available alarms; common alarm as minimum
  9. Chiller Status
  10. Enable/Disable
  11. Current Limit Percent
  12. CHW Setpoint and Setpoint Reset
  13. Oil pressure
  14. Evaporator Approach
  15. Condenser Approach
  16. Proof of CHW and CW Flow

**PART III. EXECUTION**

**3.01 INSPECTION:**

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

**3.02 INSTALLATION OF CONTROL SYSTEMS:**

- A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
- B. Contractor shall provide all interface devices and software to provide an integrated system.
- C. Contractor shall closely coordinate with the University, or designated representative, to establish IP addresses and communications to assure proper operation of the building control system with EBI.

*END OF SECTION 23 0904*

**SECTION 23 0905 - BAS SOFTWARE AND PROGRAMMING**

*Note to the Design AE: The AE and project manager should discuss the project with USC. There is a 'Preface' document describing how to employ this and other USC controls-related Guide Specifications. The AE is instructed to consult the Preface document for guidance on the generic BACnet nature of this specification, methods for deleting non-applicable text, and the use and deletion of Editor's Note's before proceeding to customize this specification.*

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**PART I. GENERAL**

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- B. Programming Description
- C. Control Algorithms
- D. Energy Management Applications

- E. Password Protection
- F. Alarm Reporting
- G. Trending
- H. Data Acquisition and Storage
- I. Point Structuring
- J. Dynamic Color Graphics

#### **1.02 RELATED DOCUMENTS:**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Section *(Insert Applicable Specification Section)* - Basic Mechanical Requirements
- C. Section 23 0900 – Building Automation System (BAS) General
- D. Section 23 0901 - BAS Basic Materials, Interface Devices, and Sensors
- E. Section 23 0902 - BAS Operator Interfaces
- F. Section 23 0903 - BAS Field Panels
- G. Section 23 0904 - BAS Communications Devices
- H. Section 23 0993 - Sequences of Operation
- I. Section 23 0801 - BAS Commissioning

#### **1.03 DESCRIPTION OF WORK:**

- A. Fully configure systems and furnish and install all software, programming and dynamic color graphics for a complete and fully functioning system as specified.
- B. Refer to *Section 23 0900 – Building Automation System (BAS)* for general requirements as well as requirements for interface with the Enterprise Buildings Integrator (EBI) Network.
- C. Refer to *(Insert Applicable Specification Section) - Sequence of Operation* for specific sequences of operation for controlled equipment.

#### **1.04 LICENSING**

- A. Include added point licensing for all software packages at all required workstations.
- B. All operator interfaces, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the University.
- C. All software should be available on all Portable Operator Terminals (POTs). Hardware and software keys to provide all rights shall be installed on all workstations. At least 2 sets of CDs shall be provided with backup software for all software provided, so that the University may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses.

- D. Provide licensing and original software copies for each POTs.
- E. Provide licensing and original software copies for each remote graphic workstation. Licenses for remote graphic workstations shall allow for access to any site and shall not be restricted to accessing only the LANs included in this project.
- F. Upgrade all software packages to the release (version) in effect at the end of the Warranty Period.
- G. Refer to *Section 23 0900 – Building Automation System (BAS) General* for further requirements.

## **PART II. PRODUCTS**

### **2.01 SYSTEM SOFTWARE-GENERAL**

- A. **Functionality and Completeness:** The Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified. The Contractor shall include all software and programming not specifically itemized in these Specifications, which is necessary to implement, maintain, operate, and diagnose the system in compliance with these Specifications.
- B. **Configuration:** The software shall support the system as a distributed processing network configuration.

### **2.02 CONTROLLER SOFTWARE**

- A. **BC Software Residency:** Each BC as defined below shall be capable of control and monitoring of all points physically connected to it. All software including the following shall reside and execute at the BC:
  - 1. Real-Time Operating System software
  - 2. Real-Time Clock/Calendar and network time synchronization
  - 3. BC diagnostic software
  - 4. LAN Communication software/firmware
  - 5. Direct Digital Control software
  - 6. Alarm Processing and Buffering software
  - 7. Energy Management software
  - 8. Data Trending, Reporting, and Buffering software
  - 9. I/O (physical and virtual) database
  - 10. Remote Communication software
- B. **AAC/ASC Software Residency:** Each AAC/ASC as defined below shall be capable of control and monitoring of all points physically connected to it. As a minimum, software including the following shall reside and execute at the AAC/ASC. Other software to support other required functions of the AAC/ASC may reside at the BC or LAN interface device (specified in Section 23 0904) with the restrictions/exceptions per application provided in Section 23 0903:
  - 1. Real-Time Operating System software
  - 2. AAC/ASC diagnostic software



3. LAN Communication software
  4. Control software applicable to the unit it serves that will support a single mode of operation
  5. I/O (physical and virtual) database to support one mode of operation
- C. **Stand Alone Capability:** BC shall continue to perform all functions independent of a failure in other BC/AAC/ASC or other communication links to other BCs/AACs/ASCs. Trends and runtime totalization shall be retained in memory. Runtime totalization shall be available on all digital input points that monitor electric motor status. Refer also to Section 23 0903 for other aspects of stand alone functionality.
- D. **Operating System:** Controllers shall include a real-time operating system resident in ROM. This software shall execute independently from any other devices in the system. It shall support all specified functions. It shall provide a command prioritization scheme to allow functional override of control functions. Refer also to Section 23 0903 for other aspects of the controller's operating system.
- E. **Network Communications:** Each controller shall include software/firmware that supports the networking of CUs on a common communications trunk that forms the respective LAN. Network support shall include the following:
1. Building Controller/Primary LAN shall be a high-speed network designed and optimized for control system communication. If a Primary LAN communications trunk is severed, BCs shall reconfigure into two separate LANs and continue operations without interruption or Operator intervention.
  2. Controller communication software shall include error detection, correction, and re-transmission to ensure data integrity.
  3. Operator/System communication software shall facilitate communications between other BCs, all subordinate AACs/ASCs, Gateways and LAN Interface Devices or Operator Workstations. Software shall allow point interrogation, adjustment, addition/deletion, and programming while the controller is on line and functioning without disruption to unaffected points. The software architecture shall allow networked controllers to share selected physical and virtual point information throughout the entire system.
- F. **EBI Network Point Database/Summary Table:** All points included in the typical equipment point list must be represented to the EBI Network in a common, open protocol format. All points should be provided as LonTalk network variables and configuration properties or BACnet standard analog, binary, schedule, or trend objects. Naming conventions for these points and network addressing are discussed in Part III of this section. Point/system database creation and modification shall be via a user-friendly, menu-driven program. System software shall support virtual or logic point (points not representing a physical I/O) creation. Software shall support virtual points with all services specified herein. Database software shall support definition of all parameters specified in Part III of this section for a given point type. If database does not support all of these parameters, a software module shall be created and attached to the points which accomplish the respective function.
- G. **Diagnostic Software:** Controller software shall include diagnostic software that checks memory and communications and reports any malfunctions

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- H. **Alarm/Messaging Software:** Controller software shall support alarm/message processing and buffering software as more fully specified below.
- I. **Application Programs:** CUs shall support and execute application programs as more fully specified below:
1. All Direct Digital Control software, Building Automation software, and functional block application programming software templates shall be provided in a 'ready-to-use' state, and shall not require (but shall allow) University programming.
  2. Line programs shall supply preprogrammed functions to support these energy management and functional block application algorithms. All functions shall be provided with printed narratives and/or flow diagrams to document algorithms and how to modify and use them.
- J. **Security:** Controller software shall support multiple level password access restriction as more fully specified below.
- K. **Direct Digital Control:** Controller shall support application of Direct Digital Control Logic. All logic modules shall be provided pre-programmed with written documentation to support their application. Provide the following logic modules as a minimum:
1. Proportional-Integral-Derivative (PID) control with analog, PWM and floating output
  2. Two Position control (Hi or Low crossing with deadband)
  3. Single-Pole Double-Throw relay
  4. Delay Timer (delay-on-make, delay-on-break, and interval)
  5. Hi/Low Selection
  6. Reset or Scaling Module
  7. Logical Operators (And, Or, Not, Xor)
- L. **Psychrometric Parameters:** Controller software shall provide preprogrammed functions to calculate and present psychrometric parameters (given temperature and relative humidity) including the following as a minimum: Enthalpy, Wet Bulb Temperature.
- M. **Updating/Storing Application Data:** Site-specific programming residing in volatile memory shall be uploadable/downloadable from an OWS connected locally, to the Primary LAN, to the Local Supervisory LAN and remotely via the internet and modem and telephone lines as applicable but all must be available. Initiation of an upload or download shall include all of the following methods; Manually, Scheduled, and Automatically upon detection of a loss or change.
- N. **Restart:** System software shall provide for orderly shutdown upon loss of power and automatic restart upon power restoration. Volatile memory shall be retained; outputs shall go to programmed fail (open, closed, or last) position. Equipment restart shall include a user definable time delay on each piece of equipment to stagger the restart. Loss of power shall be alarmed at operator interface indicating date and time.
- O. **Time Synchronization:** Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall be able to select to set the time and date for an individual device, devices on a single network, or

all devices simultaneously. Automatic time synchronization shall be provided using BACnet services.

- P. **Misc. Calculations:** System software shall automate calculation of psychometric functions, calendar functions, kWh/kW, and flow determination and totalization from pulsed or analog inputs, curve-fitting, look-up table, input/output scaling, time averaging of inputs and A/D conversion coefficients.

### 2.03 APPLICATION PROGRAMMING DESCRIPTION

- A. The application software shall be user programmable.
- B. This specification generally requires a programming convention that is logical, easy to learn, use, and diagnose. General approaches to application programming shall be provided by one, or a combination, of the following conventions:
1. **Point Definition:** provide templates customized for point type, to support input of individual point information. Use standard BACnet Objects or LonWorks SNVTs as applicable.
  2. **Graphical Block Programming:** Manipulation of graphic icon 'blocks', each of which represents a subroutine, in a functional/logical manner forming a control logic diagram. Blocks shall allow entry of adjustable settings and parameters via pop-up windows. Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time block output values.
  3. **Functional Application Programming:** Pre-programmed application specific programs that allow/require limited customization via 'fill-in-the-blanks' or "question/answer" edit fields. Typical values would be setpoints gains, associated point names, alarm limits, etc.
  4. **Line Programming:** Textual syntax-based programming in a language similar to BASIC designed specifically for HVAC control. Subroutines or functions for energy management applications, setpoints, and adjustable parameters shall be customizable, but shall be provided preprogrammed and documented.
- C. Provide a means for testing and/or debugging the control programs both off-line and on-line.

### 2.04 ENERGY MANAGEMENT APPLICATIONS

- A. System shall have the ability to perform all of the following energy management routines via preprogrammed function blocks or template programs. As a minimum provide the following whether or not required in the software:
1. Time-of-Day Scheduling
  2. Calendar-Based Scheduling
  3. Holiday Scheduling
  4. Temporary Schedule Overrides

5. Optimal Start/Optimal Stop-based on space temperature offset, outdoor air temperature, and building heating and cooling capacitance factors as a minimum
  6. Night Setback and Morning Recovery Control, with ventilation only during occupancy
  7. Economizer Control (enthalpy or dry-bulb)
  8. Peak Demand Limiting / Load Shedding
  9. Dead Band Control
  10. Discharge Air Temperature Reset based on return air temperature and room temperature (option for both).
  11. Static Pressure Reset based on VAV box position and scheduled (option for both)
  12. Occupancy based VAV box operation (alternative).
- B. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization. Programs shall be applied to building equipment as described in the Section entitled '*Sequence of Operation*'.

## **2.05 PASSWORD PROTECTION**

- A. Multiple-level password access protection shall be provided to allow the University's authorized BAS Administrator to limit workstation control, display and database manipulation capabilities as (s)he deems appropriate for each user, based upon an assigned user name with a unique password.
- B. All passwords for the system shall be provided to the University including administrator, dealer, or factory level passwords for the systems provided under this project.
- C. Passwords shall restrict access to all Control Units.
- D. Each user name shall be assigned to a discrete access level. A minimum of five levels of access shall be supported. Alternately, a comprehensive list of accessibility/functionality items shall be provided, to be enabled or disabled for each user.
- E. A minimum of 20 user names shall be supported and programmed per the University's direction.
- F. Operators shall be able to perform only those commands available for the access level assigned to their user name.
- G. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving interface device software on-line.

## **2.06 ALARM AND EVENT MANAGEMENT REPORTING**

- A. Alarm management shall be provided to monitor, buffer, and direct alarms and messages to operator devices and memory files. Each BC shall perform distributed,

independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall a BCs ability to report alarms be affected by either operator activity at an Operator Workstation or local handheld device, or by communications with other panels on the network.

1. **Alarm Descriptor:** Each alarm or point change shall include that point's English language description, and the time and date of occurrence. In addition to the alarm's descriptor and the time and date, the user shall be able to print, display and store an alarm message to more fully describe the alarm condition or direct operator response.
  2. **Alarm Prioritization:** The software shall allow users to define the handling and routing of each alarm by their assignment to discrete priority levels. A minimum of ten priority levels shall be provided. For each priority level, users shall have the ability to enable or disable an audible tone whenever an alarm is reported and whenever an alarm returns to normal condition. Users shall have the ability to manually inhibit alarm reporting for each individual alarm and for each priority level. Contractor shall coordinate with the University on establishing alarm priority definitions.
  3. **Alarm Report Routing:** Each alarm priority level shall be associated with a unique user-defined list of operator devices including any combination of local or remote workstations, printers and workstation disk files. All alarms associated with a given priority level shall be routed to all operator devices on the user-defined list associated with that priority level. For each priority level, alarms shall be automatically routed to a default operator device in the event that alarms are unable to be routed to any operator device assigned to the priority level.
  4. **Auto-Dial Alarm Routing:** For alarm priority levels that include a remote workstation (accessed by modem) as one of the listed reporting destinations, the BC shall initiate a call to report the alarm, and shall terminate the call after alarm reporting is complete. System shall be capable of multiple retries and buffer alarms until a connection is made. If no connection is made, system shall attempt connection to an alternate dial-up workstation. System shall also be able to dial multiple pagers upon alarm activation.
  5. **Alarm Acknowledgment:** For alarm priority levels that are directed to a workstation screen, an indication of alarm receipt shall be displayed immediately regardless of the application in use at the workstation, and shall remain on the screen until acknowledged by a user having a password that allows alarm acknowledgment. Upon acknowledgment, the complete alarm message string (including date, time, and user name of acknowledging operator) shall be stored in a selected file on the workstation hard disk.
- B. It shall be possible for any operator to receive a summary of all alarms regardless of acknowledgement status; for which a particular recipient is enrolled for notification; based on current event state; based on the particular BACnet event algorithm (e.g., change of value, change of state, out of range, and so on); alarm priority; and notification class.

- C. **BACnet Alarming Services:** Where possible all alarms and events shall be implemented using standard BACnet event detection and notification mechanisms. The workstation shall receive BACnet alarm and event notifications from any gateway or BACnet controller in the system and display them to an operator. Either intrinsic reporting or algorithmic change reporting may be used but the intrinsic reporting method is preferred. The workstation shall also log alarms and events, provide a way for an operator with sufficient privilege to acknowledge alarms, and log acknowledgements of alarms. It shall be possible for an operator to receive, at any time, a summary of all alarms that are currently in effect at any site whether or not they have been acknowledged. Operators shall also be able to view and change alarm limits for any alarm at the appropriate password level.
- D. **EBI Alarming Services:** Real-time alarming shall be available to the EBI Network. This shall be either accomplished by (i) having the Local Supervisory LAN utilize LonTalk or BACnet over IP, at which point the EBI Router will pick up and forward the alarms; or (ii) by providing a gateway forming that BACnet over IP LAN to which the EBI Network router can connect. The BACnet Alarm and Event Object shall be supported as specified in Section 23 0904.
- E. **Alarm Historical Database:** The database shall store all alarms and events object occurrences in an ODBC or an OLE database-compliant relational database. Provide a commercially available ODBC driver or OLE database data provider, which would allow applications to access the data using standard Microsoft Windows Data Services.

## 2.07 TRENDING

- A. The software shall display historical data in both a tabular and graphical format. The requirements of this trending shall include the following:
  - 1. Provide trends for all physical points, virtual points and calculated variables.
  - 2. LonTalk trends or BACnet Trend Objects are preferred but where not possible trend data shall be stored in relational database format as specified in herein under Data Acquisition and Storage.
  - 3. In the graphical format, the trend shall plot at least 4 different values for a given time period superimposed on the same graph. The 4 values shall be distinguishable by using unique colors. In printed form the 4 lines shall be distinguishable by different line symbology. Displayed trend graphs shall indicate the engineering units for each trended value.
  - 4. The sample rate and data selection shall be selectable by the operator.
  - 5. The trended value range shall be selectable by the operator.
  - 6. Where trended values on one table/graph are COV, software shall automatically fill the trend samples between COV entries.
- B. **Control Loop Performance Trends:** Controllers incorporating PID control loops shall also provide high resolution sampling in less than six second increments for verification of control loop performance.
- C. **Data Buffering and Archiving:** Trend data shall be buffered at the BC, and uploaded to hard disk storage when archival is desired. All archived trends shall be transmitted to the on-site OWS or CSS as applicable. Uploads shall occur based upon a user-

defined interval, manual command, or automatically when the trend buffers become full.

- D. **Time Synchronization:** Provide a time master that is installed and configured to synchronize the clocks of all LonTalk or BACnet devices supporting time synchronization. Synchronization shall be done using Coordinated Universal Time (UTC). All trend sample times, both BACnet and LonTalk, shall be able to be synchronized. The frequency of time synchronization message transmission shall be selectable by the operator.

## 2.08 DYNAMIC PLOTTING

- A. Provide a utility to dynamically plot in real-time at least 4 values on a given 2-dimensional dynamic plot/graph with at least two Y-axes. At least 5 dynamic plots shall be allowed simultaneously.

## 2.09 DATA ACQUISITION AND STORAGE

- A. All points included in the typical equipment point list must be represented in a common, open or accessible format. All points should be provided as LonTalk SNVT's or BACnet standard analog, binary, schedule, or trend objects when possible. Naming conventions for these points and network addressing are discussed in the 'Point Naming Conventions' paragraph below.
- B. Non-BACnet data from the BAS shall be stored in relational database format. The format and the naming convention used for storing the database files shall remain consistent across the database and across time. The relational structure shall allow for storage of any additional data points, which are added to the BAS in future. The metadata/schema or formal descriptions of the tables, columns, domains, and constraints shall be provided for each database.
- C. The database shall allow applications to access the data while the database is running. The database shall not require shutting down in order to provide read-write access to the data. Data shall be able to be read from the database without interrupting the continuous storage of trend data being carried by the BAS.
- D. The database shall be ODBC or OLE database compliant. Provide a commercially-available ODBC driver or OLE database data provider, which would allow applications to access the data via Microsoft Windows standard data access services.

## 2.10 TOTALIZATION

- A. The software shall support totalizing analog, digital, and pulsed inputs and be capable of accumulating, storing, and converting these totals to engineering units used in the documents. These values shall generally be accessible to the Operator Interfaces to support management-reporting functions.
- B. Totalization of electricity use/demand shall allow application of totals to different rate periods, which shall be user definable.
- C. When specified to provide electrical or utility Use/Demand, the Contractor shall obtain from the local utility all information required to obtain meter data, including k factors, conversion constants, and the like.

## 2.11 EQUIPMENT SCHEDULING

- A. Provide a graphic utility for user-friendly operator interface to adjust equipment-operating schedules.
- B. All schedules shall be implemented using LonTalk schedules or BACnet objects and messages. All building systems with date and time scheduling requirements shall have schedules represented by the BACnet Schedule object. All operators shall be able to view the entries for a schedule. Operators with sufficient privilege shall be able to modify schedule entries from any BACnet workstation.
- C. Scheduling feature shall include multiple seven-day master schedules, plus holiday schedule, each with start time and stop time. Master schedules shall be individually editable for each day and holiday.
- D. Scheduling feature shall allow for each individual equipment unit to be assigned to one of the master schedules.
- E. Timed override feature shall allow an operator to temporarily change the state of scheduled equipment. An override command shall be selectable to apply to an individual unit, all units assigned to a given master schedule, or to all units in a building. Timed override shall terminate at the end of an operator selectable time, or at the end of the scheduled occupied/unoccupied period, whichever comes first. A password level that does not allow assignment of master schedules shall allow a timed override feature.
- F. A yearly calendar feature shall allow assignment of holidays, and automatic reset of system real time clocks for transitions between daylight savings time and standard time.

## 2.12 POINT STRUCTURING AND NAMING

- A. **General:** The intent of this section is to require a consistent means of naming points across the University Enterprise. Contractor shall configure the systems from the perspective of the Enterprise, not solely the local project/building. The following requirement establishes a standard for naming points and addressing Buildings, Networks, Devices, Instances, and the like. The convention is tailored towards the BACnet-based *EBI Network* and as such, the interface shall always use this naming convention. Native BACnet systems shall also use this naming convention. For non-native BACnet systems, the naming convention shall be implemented as much as practical, and any deviations from this naming convention shall be approved by the University.
- B. **Point Summary Table**
  - 1. The term 'Point' is a generic description for the class of object represented by analog and binary inputs, outputs, and values.
  - 2. With each schematic, Contractor shall provide a Point Summary Table listing:
    - a) Building number and abbreviation
    - b) System type
    - c) Equipment type



- d) Room number
  - e) Point suffix
  - f) Full point name (see Point Naming Convention paragraph)
  - g) Point description
  - h) Ethernet backbone network number,
  - i) Network number
  - j) Device ID
  - k) Device MAC address
  - l) Object ID (object type, instance number)
  - m) Engineering units.
3. Additional fields for non-BACnet systems shall be appended to each row. Point Summary Table shall be provided in both hard copy and in electronic format (ODBC-compliant).
  4. Point Summary Table shall also illustrate Network Variables/BACnet Data Links/LonWorks Bindings.
  5. The BAS Contractor shall coordinate with the University's representative and compile and submit a proposed Point Summary Table for review prior to any object programming or project startup.
  6. The Point Summary Table shall be kept current throughout the duration of the project by the Contractor as the Master List of all points for the project. Project closeout documents shall include an up-to-date accurate Point Summary Table. The Contractor shall deliver to the University the final Point Summary Table prior to final acceptance of the system. The Point Summary Table shall be used as a reference and guide during the commissioning process.
  7. The Point Summary Table shall contain all data fields on a single row per point. The Point Summary Table is to have a single master source for all point information in the building that is easily sorted and kept up-to-date. Although a relational database of Device ID-to-point information would be more efficient, the single line format is required as a single master table that will reflect all point information for the building. The point description shall be an easily understandable English-language description of the point.

Point Summary Table ExampleRow Headers and Examples

(Transpose for a single point per row format)

Building Name	XYZ_
System Type	Cooling
Equipment Type	Chiller
Point Suffix	CHLR1KW
Point Name (Object Name)	XYZ_COOLING.CHILLER.CHLR1KW
Point Description (Object Description)	Chiller 1 kW
Ethernet Network Number	600
Network Number	610
Device ID	1024006
Device MAC address	24
Object Type	AI
Instance Number	4
Engineering Units	KW
Network Variable?	True
Server Device	1024006
Client Devices	1028006
Included with Functional	

**C. Point Naming Convention**

1. All point names shall adhere to the format as established below. Said objects shall include all physical I/O points, calculated points used for standard reports, and all application program parameters. For each BAS object, a specific and unique name shall be required.
2. For each point, four (4) distinct descriptors shall be linked to form each unique object name: Building, System, Equipment, and Point. All keyboard characters except a space are allowable. Each of the four descriptors must be bound by a period to form the entire object name. Reference the paragraphs below for an example of these descriptors.
3. The University shall designate the *Building* descriptor. The *System* descriptor shall further define the object in terms of air handling, cooling, heating, or other system. The *Equipment* descriptor shall define the equipment category; e.g., Chiller, Air Handler, or other equipment. The *Point* descriptor shall define the hardware or software type or function associated with the equipment; e.g., supply temperature, water pressure, alarm, mixed air temperature setpoint, etc. and shall contain any numbering conventions for multiples of equipment; e.g., CHLR1KW, CHLR2KW, BLR2AL (Boiler 2 Alarm), HWP1ST (Hot Water Pump 1 Status).
4. A consistent object (point) naming convention shall be utilized to facilitate familiarity and operational ease across the EBI Network. Inter-facility consistency shall be maintained to ensure transparent operability to the greatest degree possible. The table below details the object naming convention and general format of the descriptor string.

BACnet Object Name Requirements

Descriptors		Comment
Building Name	XYZ	The Master Building List also has the correct abbreviations for each building.
System	AIRHANDLING EXHAUST HEATING COOLING UTILITY ENDUSE MISC	Boilers and ancillary equipment Chillers and ancillary equipment Main electrical and gas meters Specific building loads by type
Equipment	BOILERS CHILLERS FACILITY TOWERS WEATHER	Non-specific boiler system points Non-specific chiller system points
Point Suffix	See Input/Output point summary table for conventions	

5. **Examples:** Within each object name, the descriptors shall be bound by a period. Within each descriptor, words shall not be separated by dashes, spaces, or other separators as follows:

- a) XYZ\_COOLING.CHILLERS.CHWP1ST
- b) XYZ\_HEATING.BOILERS.BLR1CFH

**D. Device Addressing Convention:**

1. Network numbers and Device Object IDs shall be unique throughout the network.
2. All assignment of network numbers and Device Object IDs shall be coordinated with the University.
3. Each Network number shall be unique throughout all facilities and shall be assigned in the following manner unless specified otherwise:

**BBBFF**, where: BBB = 1-655 assigned to each building, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building.

4. Each Device Object Identifier property shall be unique throughout the system and shall be assigned in the following manner unless specified otherwise:

**XXFFBBB**, where: XX = number 0 to 40, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building. BBB = 1-655 assigned to each building.

5. The BAS Contractor shall coordinate with the University or a designated representative to ensure that no duplicate Device Object IDs occur.
6. Alternative Device ID schemes or cross project Device ID duplication if allowed shall be approved before project commencement by the University.

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## 2.13 OPERATOR INTERFACE GRAPHICS DEVELOPMENT AND SOFTWARE

- A. Graphic software shall facilitate user-friendly interface to all aspects of the EBI System Software. The intent of this specification is to require a graphic package that shall facilitate logical and simple system interrogation, modification, configuration, and diagnosis.
- B. Graphic software shall support multiple simultaneous windows to be displayed and resizable in a 'Windows'-like environment. All functions excepting text entry functions shall be executable with a mouse, finger or stylus for touch screen capabilities.
- C. Graphic software shall provide for multitasking such that third-party programs can be used while the graphics software is on line. Software shall provide the ability to alarm graphically even when operator is in another software package.
- D. Operating system software shall be most current version of *Microsoft Windows, used by the University*.
- E. University will provide Graphic Standards and Formats to be used for generating graphics for the specific building systems and floor plans.
- F. The BAS Contractor shall create detailed and accurate color graphic displays of building plans, floor plans, room environment (i.e., room temp, humidity, CO<sub>2</sub>, etc.) and mechanical and electrical systems. All web pages shall have the stylesheet applied to them in order to display the graphics accordingly. These graphics shall display all point information from the database including any attributes associated with each point (i.e., engineering units, etc.). In addition, operators shall be able to command equipment or change set points from a graphic through the use of the mouse, finger or stylus.
- G. **Display Penetration:** The operator interface shall allow users to access the various system graphic displays via a graphical penetration scheme by using the mouse, finger or stylus to select from menus or 'button' icons. Each graphic display shall be capable of having a unique list of other graphic displays that are directly linked through the selection of a menu item or button icon.
- H. **Dynamic Data Displays:** Dynamic physical point values shall automatically updated at a minimum frequency of 6 updates per minute without operator intervention. Point value fields shall be displayed with a color code depicting normal, abnormal, override and alarm conditions.
- I. **Point Override Feature:** Each displayed point shall be individually enabled/disabled to allow mouse-driven override of digital points or changing of analog points. Such overrides or changes shall occur in the control unit, not just in the workstation software. The graphic point override feature shall be subject to password level protection. Points that are overridden shall be reported as an alarm, and shall be displayed in a coded color. The alarm message shall include the operator's user name. A list of points that are currently in an override state shall be available through menu selection.
- J. **Dynamic Symbols:** Symbols will change in appearance based on the value of an associated point.

1. Analog symbol: A line or linear bar symbol will be used to represent the value of an analog point.
  2. Digital symbol: Symbols such as switches, pilot lights, rotating fan wheels, will be used to represent the value of digital input and output points.
  3. Point Status Color: Graphic presentations shall indicate different colors for different point statuses. (For instance, green = normal, red = alarm, gray (or ‘???’) for non-response.
- K. **Graphics Development:** Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.
1. The Contractor shall develop and deliver building specific graphics compatible with the Honeywell EBI system. Control points shall be mapped to the corresponding system specific graphics. Graphics are to be provided depicting air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), mechanical system components (e.g., pumps, chillers, cooling towers, boilers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.
  2. The graphics package shall use a mouse, finger, stylus or similar pointing device to allow the user to perform the following:
    - a. Define symbols
    - b. Position items on graphic displays
    - c. Attach physical or virtual points to a graphic
    - d. Define background displays
    - e. Define connecting lines and curves
    - f. Locate, orient and size descriptive text
    - g. Define and display colors for all elements
    - h. Establish correlation between symbols or text and associated system points or other displays.
    - i. Create hot spots or hyperlinks to other graphic displays or other functions in the software.

#### 2.14 REMOTE PERSONAL COMPUTER WORKSTATION GRAPHIC SOFTWARE PERSONAL COMPUTER WORKSTATION GRAPHIC SOFTWARE

*Edit the following based on how operators will remotely connect, phone or Internet*

- L. Remote graphic operator software shall provide all the functionality specified for the local graphic software. It shall also provide for dial-up communications using the specified modems via commercial telephone lines to connect to the Local Supervisory or Primary LAN, and using the Internet.
- M. Software shall not require graphic images to be sent across the phone lines or 56Kbps or slower Internet connection. Graphic images shall reside on the remote operator workstation hard drive and all licenses must be provided for the graphic software on the remote machine. . Exceptions to this requirement include:

1. System configuration uses an Internet server and presents web pages that can be pulled up using a standard browser.
  2. System configuration uses an Internet server and presents the standalone application running locally but controlled via a remote browser. Operator Interface Graphical Software application must therefore support multi-instancing to allow multiple simultaneous remote connections and use of the graphic software.
- N. Software shall be capable of initiating communication to the any LAN, upon user command, to perform all specified functions. Software shall be capable of initiating communication to the LANs in accordance with user-programmed time schedules to upload trend and report data. Software shall be capable of communicating from the LAN in accordance with user-programmed time schedules to report alarms, upload trend, and report data. Software shall automatically terminate the communication whenever all applications requiring modem connection are closed.

### **PART III. EXECUTION**

#### **3.01 SYSTEM CONFIGURATION**

- A. Contractor shall thoroughly and completely configure BAS system software, supplemental software, network communications, OWS/POT, and remote communications.

#### **3.02 SITE-SPECIFIC APPLICATION PROGRAMMING**

- A. Provide all database creation and site-specific application control programming as required by these Specifications, national and local standards and for a fully functioning system. Contractor shall provide all initial site-specific application programming and thoroughly document programming in meeting the intent of the written sequences of operation. It is the Contractor's responsibility to request clarification on sequence issues that require such clarification.
- B. All site-specific programming shall be fully documented and submitted for review and approval, both prior to downloading into the panel, at the completion of functional performance testing, and at the end of the warranty period.
- C. All programming, graphics and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the project will be the property of the University and shall remain on the workstation(s)/server(s) at the completion of the project.

#### **3.03 PASSWORD SETUP**

*The following is simply a template. Coordinate with facilities personnel for actual needs*

- A. Set up the following password levels to include the specified capabilities:
1. Level 1: (University's BAS Administrator)
    - a) Level 2 capabilities
    - b) View, add, change and delete user names, passwords, password levels

- 
- c) All unrestricted system capabilities including all network management functions.
  - 2. Level 2: (Programmer)
    - a) Level 3 capabilities
    - b) Configure system software
    - c) Modify control unit programs
    - d) Modify graphic software
    - e) Essentially unrestricted except for viewing or modifying user names, passwords, password levels
  - 3. Level 3: (Senior HVAC Technician)
    - a) Level 4 capabilities
    - b) Override output points
    - c) Change setpoints
    - d) Change equipment schedules
    - e) Exit BAS software to use third party programs
  - 4. Level 4: (Junior HVAC Technician)
    - a) Level 5 capabilities
    - b) Acknowledge alarms
    - c) Temporarily override equipment schedules
  - 5. Level 5: (HVAC Technician Trainee)
    - a) Display all graphic data
    - b) Trend point data
- B. Contractor shall assist the University's operators with assigning user names, passwords and password levels.

### **3.04 POINT PARAMETERS**

- A. Provide the following minimum programming for each analog input:
- 1. Name
  - 2. Address
  - 3. Scanning frequency or COV threshold
  - 4. Engineering units
  - 5. Offset calibration and scaling factor for engineering units
  - 6. High and low alarm values and alarm differentials for return to normal condition
  - 7. High and low value reporting limits (reasonableness values), which shall prevent control logic from using shorted or open circuit values.
  - 8. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary

and/or secondary controlling networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure of any network over which the point value is transferred.

9. Selectable averaging function that shall average the measured value over a user selected number of scans for reporting.
- B. Provide the following minimum programming for each analog output:
1. Name
  2. Address
  3. Output updating frequency
  4. Engineering units
  5. Offset calibration and scaling factor for engineering units
  6. Output Range
  7. Default value to be used when the normal controlling value is not reporting.
- C. Provide the following minimum programming for each digital input:
1. Name
  2. Address
  3. Engineering units (on/off, open/closed, freeze/normal, etc.)
  4. Debounce time delay
  5. Message and alarm reporting as specified
  6. Reporting of each change of state, and memory storage of the time of the last change of state
  7. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
- D. Provide the following minimum programming for each digital output:
1. Name
  2. Address
  3. Output updating frequency
  4. Engineering units (on/off, open/closed, freeze/normal, etc.)
  5. Direct or Reverse action selection
  6. Minimum on-time
  7. Minimum off-time
  8. Status association with a DI and failure alarming (as applicable)
  9. Reporting of each change of state, and memory storage of the time of the last change of state.
  10. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
  11. Default value to be used when the normal controlling value is not reporting.



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*The following must be edited to be project specific*

### **3.05 TRENDS**

- A. Contractor shall establish and store trend logs. Trend logs shall be prepared for each physical input and output point, and all dynamic virtual points such as setpoints subject to a reset schedule, intermediate setpoint values for cascaded control loops, and the like as directed by the University.
- B. The University will analyze trend logs of the system operating parameters to evaluate normal system functionality. Contractor shall establish these trends and ensure they are being stored properly.
  - 1. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field or single date stamp. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals and be presented in a maximum of two separate 2-dimensional formats with time being the row heading and field name being the column heading.
- C. Sample times indicated as COV ( $\pm$ ) or change-of-value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When output to the trending file, the latest recorded value shall be listed with any given time increment record. The samples shall be filled with the latest values also if the points include different time intervals. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the interval common to the unit.
- D. Trending intervals or COV thresholds shall be dictated by the University upon system start-up.
- E. The Contractor shall demonstrate functional trends as specified for a period of 30 days after successful system demonstration before final acceptance of the system.

### **3.06 TREND GRAPHS**

- A. Prepare controller and workstation software to display graphical format trends. Trended values and intervals shall be the same as those specified
- B. Lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.
- C. Indicate engineering units of the y-axis values; e.g. degrees F., inches w.g., Btu/lb, percent open, etc.
- D. The y-axis scale shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.
- E. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended.
- F. All points trended for one HVAC subsystem (e.g. air handling unit, chilled water system, etc.) shall be trended during the same trend period.
- G. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

*AE must edit the following to be project specific*

### 3.07 ALARMS

- A. **Override Alarms:** Any point that is overridden through the override feature of the graphic workstation software shall be reported as a Level 3 alarm.
- B. **Analog Input Alarms:** For each analog input, program an alarm message for reporting whenever the analog value is outside of the programmed alarm limits and the system is scheduled to be operating. Report a 'Return-to-Normal' message after the analog value returns to the normal range, using a programmed alarm differential. The alarm limits shall be individually selected by the Contractor based on the following criteria:
1. Space temperature, except as otherwise stated in sequence of operation:  
Level 3
    - a) Low alarm: 64°F
    - b) Low return-to-normal: 68°F
    - c) High alarm: 80°F
    - d) High return-to-normal: 75°F
  2. Controlled media temperature other than space temperature (e.g. AHU discharge air temperature, steam converter leaving water temperature, condenser water supply, chilled water supply, etc.): Level 3 (If controlled media temperature setpoint is reset, alarm setpoints shall be programmed to follow setpoint)
    - a) Low alarm: 4°F below setpoint
    - b) Low return-to-normal: 2°F below setpoint
    - c) High alarm: 4°F above setpoint
    - d) High return-to-normal: 2°F above setpoint.
  3. AHU mixed air temperature: Level 4
    - a) Low alarm: 45°F
    - b) Low return-to-normal: 46°F
    - c) High alarm: 90°F
    - d) High return-to-normal: 89°F
  4. Duct Pressure:
    - a) Low alarm: 0.25" w.g. below setpoint
    - b) Low return-to-normal: 0.15" w.g. below setpoint
    - c) High alarm: 0.25" w.g. above setpoint
    - d) High return-to-normal: 0.15" w.g. above setpoint
  5. Space humidity (critical spaces only):
    - a) Low alarm: 35%

- b) Low return-to-normal: 40%
  - c) High alarm: 75%
  - d) High return-to-normal: 70%
- C. **HOA Switch Tampering Alarms:** The Sequences of Operation are based on the presumption that motor starter Hand-Off-Auto (HOA) switches are in the ‘Auto’ position. [\[If a motorized equipment unit starts without a prior start command from the FPM Facilities, \(as sensed by status sensing device\), then FPM Facilities shall perform the remaining sequence as specified.\]](#) BAS shall also enunciate the following Level 5 alarm message if status indicates a unit is operational when the run command is not present:
- 1. *DEVICE XXXX FAILURE:* Status is indicated on *{the device}* even though it has been commanded to stop. Check the HOA switch, control relay, status sensing device, contactors, and other components involved in starting the unit. Acknowledge this alarm when the problem has been corrected.
- D. **Maintenance Alarms:** Enunciate Level 5 alarms when runtime accumulation exceeds a value specified by the operator
- 1. *DEVICE XXXX REQUIRES MAINTENANCE.* Runtime has exceeded specified value since last reset.
- E. See requirements for additional equipment-specific alarms specified in [{Section XXXXX - Sequences of Operation}](#).

### 3.08 GRAPHIC SCREENS

*AE must provide electronic control design drawings. Also edit the following to be project specific.*

- A. **Floor Plan Displays:** The contract document drawings will be made available to the Contractor in AutoCAD latest release format upon request. These drawings may be used only for developing backgrounds for specified graphic displays; however the University does not guarantee the suitability of these drawings for the Contractor’s purpose.
- 1. Provide graphic floor plan displays for each room of each floor of the building. Indicate the location of all equipment that is not located on the equipment room displays. Indicate the location of sensors (i.e., temperature, humidity, etc.) associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHUs, etc.) on the floor plan displays. [\[Zone background color shall change based on the temperature offset from set point\]](#). Display the space temperature point adjacent to each temperature sensor symbol. Use a distinct line symbol to demarcate each terminal unit zone boundary. Use distinct colors to demarcate each air handling unit zone. [\[Mechanical floor plan drawings will be made available to the contractor upon request for the purpose of determining zone boundaries.\]](#) Indicate room numbers as provided by the University. Provide a drawing link from each space temperature sensor symbol and equipment symbol shown on the graphic floor plan displays to each corresponding equipment schematic graphic display.

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2. Provide graphic floor plan displays for each mechanical equipment room and a plan display of the roof. Indicate the location of each item of mechanical equipment. Provide a drawing link from each equipment symbol shown on the graphic plan view display to each corresponding mechanical system schematic graphic display.
  3. If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan display to the building key plan and to each of the other graphic floor plan displays.
  4. Provide a graphic site plan with links to and from each building plan.
- B. **System Schematic Displays:** Provide graphic system schematic display for each HVAC subsystem controlled with each I/O point in the project appearing on at least one graphic display. System graphics shall include flow diagrams with status, set points, current analog input and output values, operator commands, etc. as applicable. General layout of the system shall be schematically correct. Input/output devices shall be shown in their schematically correct locations. Include appropriate engineering units for each displayed point value. Verbose names (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse, finger or stylus. Indicate all adjustable set points on the applicable system schematic graphic display or, if space does not allow, on a supplemental linked-set point display.
1. Provide graphic displays for each air handling system. Indicate outside air temperature and enthalpy, and mode of operation as applicable (i.e., occupied, unoccupied, warm-up, cool-down). Link displays for air handlers to the heating system and cooling system graphics. Link displays for supply and exhaust systems if they are not combined onto one display.
  2. Provide a graphic display for each zone. Provide links to graphic system schematic displays of air handling units that serve the corresponding zone.
  3. Provide a cooling system graphic display showing all points associated with the chillers, cooling towers and pumps. Indicate outside air dry-bulb temperature and calculated wet-bulb temperature. Link displays for chilled water and condenser water systems if they cannot fit onto one cooling plant graphic display.
  4. Link displays for heating and cooling system graphics to utility history reports showing current and monthly electric uses, demands, peak values, and other pertinent values.
- C. **Bar Chart Displays:** On each graphic Bar Chart Display, provide drawing links to the graphic air handling unit schematic displays.
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1. Provide a graphic chilled water valve display showing the analog output signal of all chilled water valves in a bar chart format, with signals expressed as percentage of fully open valve (percentage of full cooling). Indicate the discharge air temperature and set point of each air handling unit, cooling system chilled water supply and return temperatures and the outside air temperature and humidity on this graphic. Provide drawing links between the graphic cooling plant display and this graphic display.
  2. Provide a graphic heating water valve display showing the analog output signal of all air handling unit heating water valves in a bar chart format, with signals expressed as percentage of fully open valve (percentage of full heating). Indicate the temperature of the controlled medium (such as AHU discharge air temperature or zone hot water supply temperature) and the associated set point and the outside air temperature and humidity.
- D. **Alarms:** Each programmed alarm shall appear on at least one graphic display. In general, alarms shall be displayed on the graphic system schematic display for the system that the alarm is associated with (for example, chiller alarm shall be shown on graphic cooling system schematic display). For all graphics, display analog values that are in a 'high alarm' condition in a red color, 'low alarm' condition in a blue color. Indicate digital values that are in alarm condition in a red color.
- E. **Graphic Standards:** University will provide templates, stylesheet and description of standard graphics used for representation of the building systems and floor plans.

*END OF SECTION 23 0905*

# USC DESIGN GUIDELINES

## SECTION 23 0993 SEQUENCE OF OPERATION

### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. System Startup
- B. Building Heating Hot Water System
- C. Building Chilled Water System
- D. Variable Volume Air Handling units fan wall
- E. VAV Temperature Control
- F. Constant Volume Air Handling units: fan wall
- G. Bypass VAV Temperature Control
- H. Under floor Air Distribution Constant Volume Air Handling Units, Single Zone
- I. Radiant Floor Control
- J. Radiant Chilled Water Loop Control
- K. Radiant Panel Zone Control
- L. Computer Room Air Conditioning Units (CRAC)
- M. Chilled Beams
- N. Projector Room Exhaust systems – Ground floor screening rooms.
- O. Projector Room Exhaust systems
- P. Exhaust Fans with Schedule Control
- Q. Fans with Manual Control
- R. Plumbing Equipment
- S. CHILLED WATER-FAN COIL UNITS

#### 1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including the General Conditions and Supplementary Conditions and other Division-1 Specification Sections, apply to this Section.
- B. Section 23 0900 - Building Automation System (BAS) General
- C. Section 23 0901 - BAS Basic Materials, Interface Devices, and Sensors
- D. Section 23 0902 - BAS Operator Interfaces
- E. Section 23 0903 - BAS Field Panels

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- F. Section 23 0904 - BAS Communications Devices
- G. Section 23 0905 - BAS Software
- H. Section 23 0801 - BAS Commissioning

### 1.03 SYSTEM DESCRIPTION

- A. This Section defines the manner and method by which the controls operate and sequence the controlled equipment. Included in this section are general requirements and logic strategies that expand on the specific sequences shown on the drawings. *Specific drawing sequences refer to this section and reference the logic strategies as required.*
- B. Refer to the control drawings for specific sequences for individual systems.

### 1.04 SUBMITTALS

- A. Submit under provisions of Section 25010 and Division 1.
- B. Submit diagrams indicating the mechanical system controlled and all control system components. Label with settings, adjustable range of control and limits. Include written description of control sequence referencing all labeled devices and equipment.
- C. Include flow diagrams for each control system, graphically depicting control logic.
- D. Meet with the University's operations personnel or appointed representative to formulate the graphic representation of the control systems and displayed information. As a minimum, the mechanical system components, control system components, and controlled function status and values shall be displayed.

### 1.05 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Section 01770.
- B. Accurately record actual setpoints and settings of controls, including changes to sequences made after submission of shop drawings.

## PART 2 PRODUCTS

### 2.01 NOT USED

## PART 3 EXECUTION

### 3.01 GENERAL

- A. The BAS shall monitor the following items of equipment:
  - 1. Standby Generator through the local control panel contacts for activation of generator.

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### 3.02 SYSTEM STARTUP

- A. After a power outage the equipment shall be reenergized based on a predetermined schedule.
- B. Sufficient time delay shall be allowed between each phase of the start-up to prevent overload of the electrical system.

### 3.03 BUILDING HEATING HOT WATER SYSTEM

- A. CV-HHW shall modulate towards open on command from the BAS based upon a pre-programmed schedule.
- B. The building heating hot water pumps HHWP-1 and HHWP-2 shall be energized by the BAS based on a pre-programmed schedule. Each pump is furnished with a variable speed drive. Pump status shall be monitored through differential pressure switch across the pump and the differential pressure switch across the existing building. If no flow is detected, pump HHWP-1 shall be de-energized and an alarm raised at the BAS workstation and pump HHWP-2 shall be energized. Pumps shall be lead lagged through the BAS to ensure equal run time.
- C. Variable speed drives shall be provided with a Bacnet or Lon "chip" for direct connection to the BAS for monitoring and commanding variable speed drive points from the BAS workstation.
- D. When the lead pump is started by the BAS and does not start, the BAS will de-energize the pump, and energize the lag pump.
- E. Building heating hot water supply and return water temperature shall be monitored by the BAS.
- F. Building heating hot water return water flow rate shall be monitored by the BAS.
- G. The lead pump shall run continuously to maintain heating hot water differential setpoint. The lag pump shall be energized for pump efficiency or when the lag pump is needed to maintain the water differential setpoint. The pumps shall continue to run until heating hot water differential pressure setpoint can be maintained by a single pump. The BAS shall schedule the pumps on and off to maintain the most efficient system operating point.

### 3.04 BUILDING CHILLED WATER SYSTEM

- A. CV-CHW shall modulate towards open on command from the BAS based upon a pre-programmed schedule.
- B. Building chilled water supply and return water temperature shall be monitored by the BAS.
- C. Building chilled return water flow rate shall be monitored by the BAS.



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- D. Building chilled hot water supply and return water temperature shall be monitored by the BAS. Building chilled water flow status shall be monitored through differential pressure switch located across the building. If no flow is detected, an alarm raised at the BAS workstation.

### 3.05 VARIABLE VOLUME AIR HANDLING UNITS

- A. Each air handling unit shall consist of supply fan, return fan, pre and final filters, heating coil, cooling coil and economizer mixing box.
- B. Each unit shall be energized through the energy management control system (BAS) in the automatic mode based on a predetermined schedule. Provide capability for a time based override of the schedule, the time shall be variable between 1 and 4 hours. In the hand position the fan shall run bypassing all external interlocks. In the off position the fans shall not run. In the auto position the fans shall run provided all safety provisions are satisfied. Fan status shall be monitored through current sensing relays in the fan starter bucket. A high pressure safety cutout located in the air handling unit shall deactivate to unit upon a static pressure of 6.5" w.c. being detected in the cabinet.
- C. The discharge air temperature signal shall position the cooling valve to maintain discharge air temperature setpoint. This shall be reset upwards when all zone thermostats are calling for heat and downwards when all zone thermostats are calling for cooling and all VAV boxes are 100% open.
- D. When outside air enthalpy is less than return air enthalpy, the economizer dampers shall be positioned for maximum "free cooling" using outside air to maintain mixed air temperature set point. Once the outside air enthalpy is greater than the return air enthalpy the modulating economizer outside air damper shall fully close to provide minimum outside air only. The outside air shall not drop below the minimum level as detected by the OSA flow sensor. The minimum OSA damper shall modulate to maintain the minimum OSA flow setpoint as detected by OSA flow sensor.
- E. A supply duct static pressure sensor shall control the supply air fan variable speed drive to maintain supply duct static air pressure at its setpoint. The return fan shall track the supply fan through air flow measurement in the supply and return fans. Variable speed drive shall be provided with a BAS "chip" for direct connection to the BAS for monitoring and commanding the variable speed drive points from the BAS workstation.
- F. Smoke detectors located in the supply air duct shall indicate an alarm at the BAS workstation when an alarm condition is detected for secondary monitoring. The wiring and conduit for secondary monitoring, from the duct smoke detector's auxiliary contact to the BAS shall be provided by the division 16 contractor. The wiring and conduit from the duct detector for fan shut down shall be provided by the division 16 contractor.

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- G. The return air carbon dioxide level will be monitored. If the return air carbon dioxide level reaches 1000 ppm (adjustable) and is greater than the outside air carbon dioxide level, the economizer will be overridden to bring in 100% outside air. Once the level drops to 800 ppm, the normal controls will operate.
- H. A differential pressure sensor monitoring pressure drop across the filter bank shall indicate an alarm at the BAS workstation if pressure settings are exceeded.
- I. Actuation for the chilled water control valve and outside air dampers shall be normally closed. Actuation for heating water control valve shall be normally open.
- J. Refer to Paragraph 3.06 for details of variable air volume box control.

### 3.06 VAV TEMPERATURE CONTROL

- A. Room temperature sensor shall modulate the VAV box actuator to maintain room temperature setpoint. On a further call for heating, the room temperature sensor shall modulate the hot water reheat valve to maintain room temperature setpoint.

### 3.07 CONSTANT VOLUME AIR HANDLING UNITS:

- A. Each air handling unit shall consist of supply fan, return fan or associated remote relief fan, pre and final filters, cooling coil, heating coil and economizer mixing box.
- B. Each unit shall be energized through the energy management control system(BAS) in the automatic mode based on a predetermined schedule. Provide capability for a time based override of the schedule, the time shall be variable between 1 and 4 hours. In the hand position the fan shall run bypassing all external interlocks. In the off position the fans shall not run. In the auto position the fans shall run provided all safety provisions are satisfied. Fan status shall be monitored through current sensing relays in the fan starter bucket.
- C. The discharge air temperature signal shall position the cooling valve to maintain discharge air temperature setpoint. The discharge air temperature shall be reset upwards based on the outside air temperature. The discharge air temperature shall also be reset upwards upon all zone thermostats are calling for heat and downwards when all zone thermostats are calling for cooling.
- D. When outside air enthalpy is less than return air enthalpy, the economizer dampers shall be positioned for maximum "free cooling" using outside air to maintain mixed air temperature set point. Once the outside air enthalpy is greater than the return air enthalpy the modulating economizer outside air damper shall fully close to provide minimum outside air only. The outside air shall not drop below the minimum level as detected by the OSA flow sensor. The minimum OSA damper shall modulate to maintain the minimum OSA flow as detected by the OSA flow sensor.

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- E. In the event more than 10% of the zone sensors within a floor zone sensor group call for heating, the reheat coil hot water control valve shall modulate towards open. The reheat coil valve shall modulate to maintain a leaving coil temperature of 70°F (adjustable).
- F. In the event that all zones are calling for heating, the air handling unit heating coil shall reset and modulate to maintain a leaving air temperature of 65°F. The floor zone reheat coils shall reset to and modulate the reheat coil valves to maintain a leaving coil temperature of 80°F (adjustable).
- G. Smoke detectors located in the supply air duct shall indicate an alarm at the BAS workstation when an alarm condition is detected for secondary monitoring. The wiring and conduit for secondary monitoring, from the duct smoke detector's auxiliary contact to the BAS shall be provided by the Division 15 contractor. The wiring and conduit from the duct detector for fan shut down shall be provided by the Division 16 contractor.
- H. The return air carbon dioxide level will be monitored. If the return air carbon dioxide level reaches 1000 ppm (adjustable) and is greater than the outside air carbon dioxide level, the economizer will be overridden to bring in 100% outside air. Once the level drops to 800 ppm, the normal controls will operate.
- I. A differential pressure sensor monitoring pressure drop across the filter section shall indicate an alarm at the BAS workstation if pressure settings are exceeded.
- J. Actuation for the chilled water control valve and outside air dampers shall be normally closed.

### 3.08 BYPASS VAV TEMPERATURE CONTROL

- A. Room temperature sensor shall modulate the VAV box actuator to maintain room temperature set-point. On a further call for heating, the room temperature sensor shall modulate the hot water reheat valve to maintain room temperature set-point.

### 3.09 UNDERFLOOR AIR DISTRIBUTION CONSTANT VOLUME AIR HANDLING UNITS SINGLE ZONE:

- A. Each air handling unit shall consist of supply fan, return fan or associated remote relief fan, pre and final filters, runaround coil (one heat reclaim coil, one reheat coil), cooling coil, heating coil and economizer mixing box.
- B. Each unit shall be energized through the Energy Management Control System (BAS) in the automatic mode based on a predetermined schedule. Provide capability for a time based override of the schedule, the time shall be variable between 1 and 4 hours. In the hand position the fan shall run bypassing all external interlocks. In the off position the fans shall not run. In the auto position the fans shall run provided all safety provisions are satisfied. Fan status shall be monitored through current sensing relays in the fan starter bucket.

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- C. The cooling coil discharge air temperature signal shall position the chilled water valve to maintain a discharge air temperature setpoint. The unit discharge air temperature signal shall modulate the speed of the runaround coil pump to maintain a discharge air temperature setpoint. The unit discharge temperature shall be reset upwards upon all zone temperature sensors calling for heat and downwards when all zone temperature sensors are calling for cooling.
- D. Each zone sensor shall modulate the flow to each zone to satisfy the required room temperature set-point. Return air dampers shall be two position and open and close in response to the open position of the supply air dampers.
- E. When outside air enthalpy is less than return air enthalpy, the economizer dampers shall be positioned for maximum "free cooling" using outside air to maintain mixed air temperature set point. Once the outside air enthalpy is greater than the return air enthalpy the modulating economizer outside air damper shall fully close to provide minimum outside air only. The outside air shall not drop below the minimum level as detected by the OSA flow sensor. The minimum OSA damper shall modulate to maintain the minimum OSA flow as detected by the OSA flow sensor.
- F. Smoke detectors located in the supply air duct shall indicate an alarm at the BAS workstation when an alarm condition is detected for secondary monitoring. The wiring and conduit for secondary monitoring, from the duct smoke detector's auxiliary contact to the BAS shall be provided by the Division 15 contractor. The wiring and conduit from the duct detector for fan shut down shall be provided by the Division 16 contractor.
- G. The return air carbon dioxide level will be monitored for each zone. If the return air carbon dioxide level reaches 1000 ppm (adjustable) as measured in any of the spaces and is greater than the outside air carbon dioxide level, the economizer will be overridden to bring in 100% outside air. Once the level drops to 800 ppm, the normal controls will operate.
- H. A differential pressure sensor monitoring pressure drop across each filter shall indicate an alarm at the BAS workstation if pressure settings are exceeded.
- I. Actuation for the chilled water control valve and outside air dampers shall be normally closed.

### 3.10 RADIANT FLOOR CONTROL:

- A. The pumps designated for the radiant floor systems are started on a command from the BAS. The heating and cooling two way valves regulate the surface temperature of the floor to provide either heating, 80°F (adjustable) or cooling, 69°F (adjustable). In heating mode the floor surface temperature is regulated to maintain space set point temperatures. If during non-occupied periods the space temperature drops below the minimum space temperature than the radiant floor

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is activated in heating mode for a period until the required space temperature is met. This operation is directed from the BAS.

- B. In cooling mode the surface temperature of the floor is maintained at 69°F constantly. The humidity level in each space is measured by a dew point sensor located in the space, if the space humidity ratio in lb/lb approaches the dew-point of the radiant surface then the cooling valve is closed. The valve is commanded to open when the humidity ratio of the space air is higher than the cooling surface dew point temperature. This operation is directed from the BAS.

### 3.11 RADIANT CHILLED WATER LOOP CONTROL

- A. The pumps of the radiant ceiling systems are started on a command from the BAS. Control valve CV-CHW modulates to maintain a constant supply temperature of 58°F (adjustable) to the zone radiant panels as measured by the temperature sensor downstream.

### 3.12 RADIANT HOT WATER LOOP CONTROL

- A. The pumps of the radiant ceiling systems are started on a command from the BAS. Control valve CV-HHW modulates to maintain a constant supply temperature of 100°F (adjustable) to the zone radiant panels as measured by the temperature sensor downstream.

### 3.13 RADIANT PANEL ZONE CONTROL

- A. The zone two way valves regulate the space temperature to provide heating and cooling as required.
- B. In heating mode the output from the radiant ceiling panels is regulated to maintain space set point temperatures. If during non-occupied periods the space temperature drops below the minimum space temperature than the radiant ceiling is activated in heating mode for a period until the required space temperature is met. This operation is directed from the BAS.
- C. An application specific controller is used to maintain space temperature in each zone by individually controlling each radiant chilled water and radiant hot water valve in sequence, without overlap, to maintain space temperature.
  - 1. The controller shall have outputs to the radiant chilled water and radiant hot water isolation valve. Sensing of condensation on the radiant panel shall cause the controller to close the radiant chilled water isolation valve.

### 3.14 COMPUTER ROOM AIR CONDITIONING UNITS (CRAC)

- A. CRAC units shall be provided with independent standalone controllers to maintain space temperature and relative humidity set points.

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- B. The standalone controller shall modulate the chilled water valve, the humidifier to maintain the space conditions at 72°F/ 50% RH (adjustable).
- C. The BAS shall monitor the status, common trouble, space temperature and space relative humidity.
- D. The BAS shall be capable of resetting the space temperature, relative humidity and on/off status from the central BAS control station.
- E. Upon detection of common trouble, an alarm shall sound at the BAS control station.

### 3.15 PROJECTOR ROOM EXHAUST SYSTEMS

- A. The exhaust fans shall be energized through the BAS as required during the occupied periods of the respective screening room or multimedia classroom.

### 3.16 PROJECTOR ROOM EXHAUST SYSTEMS

- A. The exhaust fans shall be energized through a wall mounted switch located in the projector room.
- B. The By-pass VAV serving the respective multimedia classroom, shall modulate towards open to provide a minimum of 700 CFM to the space to prevent under pressurization.

### 3.17 EXHAUST FANS WITH SCHEDULE CONTROL

- A. The exhaust fans shall be energized through the BAS on a scheduled basis. The fan status shall be monitored through current sensing relay mounted in the fan starter bucket.

### 3.18 FANS WITH MANUAL CONTROL

- A. Manually Controlled fans shall be energized through the BAS on a scheduled basis. A local manual override switch will be provided to override the BAS command. The fan status shall be monitored through current sensing relay mounted in the fan starter bucket.

### 3.19 PLUMBING EQUIPMENT

- A. The BAS shall monitor the following plumbing equipment:
  - 1. Fluid levels in the sewage ejector pits and the sump pits through the local control panel contacts for trouble alarm.
  - 2. Hot Water Heat Exchanger Flow rates and temperatures through the local control panel contacts.

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### 3.20 CHILLED WATER-FAN COIL UNITS:

Chilled water fan coils will be used only where 24 -hour cooling is not required and does not require emergency power.

Unit On/Off:

The fan coils shall run 24 hr/day, as required, to maintain space temperature and shall be controlled by the building automation system (BAS). Temperature Control – Normal Operation:

A temperature sensor shall report zone temperature back to the BAS. The BAS shall control the chilled water control valve. When the zone temperature rises above the set point, the CHW control valve shall modulate open. When the zone temperature is below the set point, the CHW control valve will close.

In some cases, a fan coil unit will be a 4-pipe type with a heating coil. When space temperature is below the thermostat setpoint, the hot water supply valve modulates open and hot water flows through the heating coil. As space temperature increases the hot water valve modulates closed. As space temperature rises above setpoint, the thermostat signal starts to open the chilled water valve. The room thermostat throttling range and valve actuator movement should be selected to provide a “deadband” between heating and cooling so that both valves are closed when space temperature is satisfied.

### 3.21 DX-STAND ALONE FAN COIL UNITS

Various spaces are cooled using small DX fan coil units. These rooms are typically electrical rooms, mechanical rooms, tele/data rooms, and equipment closets.

The majority of these units will be on emergency power and 24 hr cooling. See the equipment schedule on the mechanical drawings to identify which systems require emergency power.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 2113 HYDRONIC PIPING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 16, 23 21 23, 23 22 16, 33 60 00 and all sections pertaining to equipment containing hydronic coils.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

- D. For purpose of this guideline, this section pertains to above ground piping of the following services: chilled water, heating hot water, condenser water. For below-grade piping, refer to 33 60 00.

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
- Required:
    - Piping systems, both new and existing, shall be designed to not exceed the following pressure drop and velocity criteria at specified locations:

Piping Location	Pressure Drop`	Velocity
Building laterals from site utility source	2 feet / 100 feet	8 FPS
Building risers and floor / level main headers	3 feet / 100 feet	8 FPS
Equipment branches / circuits or sub-headers	4 feet / 100 feet	8 FPS

- Minimum pipe sizing shall be as follows:

Description	Minimum Pipe Size
Individual branch circuit piping	Greater of 3/4" or equipment size connection
Common branch serving multiple connections	1"



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- c) Provide trapping, venting of air and drainage of system as noted in the 23 21 16 installation section. Location of all such devices shall be shown in the plans.
  - d) Provide single line pipe and instrumentation diagrams (PI&D) of the entire length back to source for all affected systems to reflect new installation or connections to existing piping systems, in order to identify major system components (coils, heat exchangers, chillers, pumps, expansion tanks, etc.) to be affected/added/deleted and changes to piping distribution that serve them.
  - e) Refer to Section 33 60 00 for approved means of backfill for underground utilities.
  - f) It is required that all valve sets include independent valves, strainers and devices separated by flanges or unions so that any device can be removed and replaced for maintenance.
  - g) Coordinate with the work of Section 33 60 00 for main chilled water entry to the building. Building engineer shall be responsible to provide appropriate anchorage and expansion to be consistent with section 23 05 16 but taking into account what residual forces and expansion may be occurring in the outdoor buried installation. Link-Seal at the entry point shall account for the outdoor buried pre-fabricated pipe remaining insulated and passing into the building. Link-Seal shall be provided under this Section and its specification shall be appropriate to the temperature of the carrier pipe. The buried pipe extension into the building shall be provided under Section 33 60 00 scope of work.
  - h) Contractor shall submit specific plan for pre-operational cleaning strategy for review. This shall include steps and temporary measures required to separate and address new versus existing piping (where applicable).
    - 1) Pre-operational cleaning plan should also take into account the implications of pressure testing (as covered under separate sections) and the goal to avoid stagnant water or corrosion in hydronic pipe systems which are not to be placed into operation immediately.
  - i) Branch piping connections should be made at top of piping mains to avoid sediment buildup within vertical branch piping connections.
  - j) Provide structural calculations and details for supports that are utilized for suspended piping that is  $\geq 6$ " nominal diameter.
  - k) Temperature sensors shall be provided on return piping for chilled and heating hot water floor level branch lines that serve multiple fan coil units and/or VAV terminal units in new multi-story buildings.
  - l) If pre-manufactured / pre-packaged valve sets with combination valves or configurations that cannot be field-dismantled are used, a separate shut-off valve for supply and return piping shall be installed to isolate valve kit. This clause does not preclude pre-fabricated valve sets built up out of individual components separated with flanges or unions.
2. Preferred: No preferences.
3. Disallowed:
- a) Mechanical grooved systems are not allowed, except at the piping connections of chillers to allow piping to swing out of the way during maintenance and tube removal operations. Proposals for utilizing this type of system will be considered under very specific circumstances on a case by case basis, approval shall be attained by FPM Engineering.

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B. Quality Assurance requirements beyond standard 1 year warranty: None required

### 3. PRODUCT REQUIREMENTS

A. Above ground HVAC piping:

1. Manufacturers:

- a) Required: No requirements
- b) Preferred:

1) Steel piping products to be manufactured domestically (Made in USA).

2. Component Characteristics:

a) Required:

1) Provide the following materials for piping and fittings:

Service	Size	Material	Joining Method
Chilled Water	≤2"	ASTM B88 Rigid Copper (Type L)	Brazed
	>2"	ASTM A53 Type E Schedule 40 Black Steel	Welded
Heating Hot Water	≤2"	ASTM B88 Rigid Copper (Type L)	Brazed
	>2"	ASTM A53 Type E Schedule 40 Black Steel	Welded
Cooling Coil Condensate	All	ASTM B88 Rigid Copper (Type M)	Soldered
Condenser Water	All	ASTM A53 Type E Schedule 40 Black Steel	Welded
Cooling Tower Chemical Feed Lines	All	PVC Schedule 80	Fused
Boiler Chemical Feed Lines	All	Schedule 10 Stainless Steel	Welded

- 2) Carbon steel piping shall comply with ASTM/ANSI standards.
- b) Preferred: No preferences

### 4. INSTALLATION REQUIREMENTS

A. Required:

1. Provide the following piping grade or slope for complete drainage and venting:

Piping Type	Slope	Direction of Fall
-------------	-------	-------------------

## USC DESIGN GUIDELINES

Piping Type	Slope	Direction of Fall
Hot water heating (supply and return)	1" per 40'-0"	Provide slope arrows on plan and provide drain valve at low points of system
Chilled Water and Condenser Water	1" per 40'-0"	Down in direction of flow
Cold condensate	1" per 40'-0"	Down in direction of flow

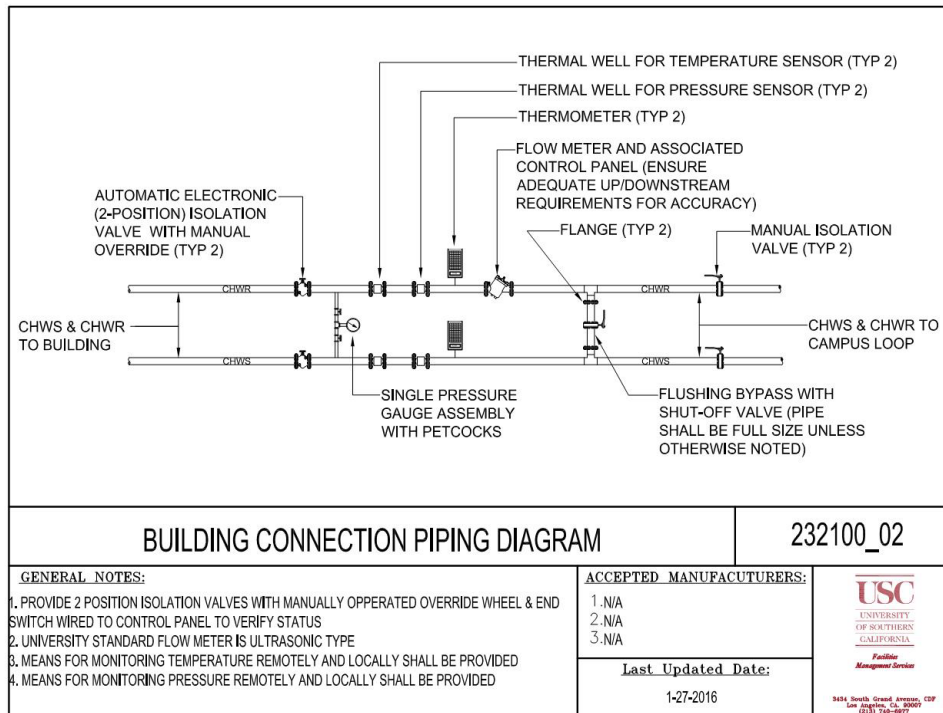
2. Install piping systems parallel to building walls.
3. Do not utilize pitch pockets at roof mounted, fixed, piping supports.
4. Provide a minimum of 8" to the underside of rooftop mounted piping, when utilizing fixed pipe supports, to allow future re-roof work.
5. Maintain piping within or distributed through building equipment rooms exposed and not concealed within or imbedded into Architectural/Structural systems (wall, floors, etc.)
6. Provide right angle (90°) fittings for changes of direction in the horizontal plane.
7. Provide industry standard pre-manufactured fittings for all piping distribution system changes in direction, changes in size, branch connections, or at final equipment connections.
8. Provide expansion devices as per Section 23 05 16.
9. Provide shut off devices as noted in section 23 05 23 and control valves as noted in the independent controls guidelines.
10. Refer to Section 23 21 16 for hydronic specialties related to air vents and drain valves.
11. Install above grade piping to be serviceable at points of isolation through and accessible ceiling system or other appropriate means.
12. Provide unions or flanges adjacent to valves, control instrumentation, regulators and at final equipment connections for removal of all appurtenances that may require maintenance or replacement.
13. Dielectric Isolation Assembly:

Pipe Size	Application (Steel to Copper Transition)	Components
2-1/2" and larger	Piping run (no disassembly requirement)	Review application with FPM Engineering
	Piping run with valve and/or equipment connection (disassembly requirement)	Pipe flanges with dielectric gaskets.
2" and smaller	Piping run (no disassembly requirement)	Steel Pipe -> Brass Coupling / Steel Pipe Fitting -> 12" Brass Nipple -> Brass Coupling -> Copper Pipe
	Piping run with valve and/or equipment connection (disassembly requirement)	Steel Pipe -> Brass Coupling / Steel Pipe Fitting -> 12" Brass Nipple -> Valve -> <u>Brass Union</u> -> Copper Pipe

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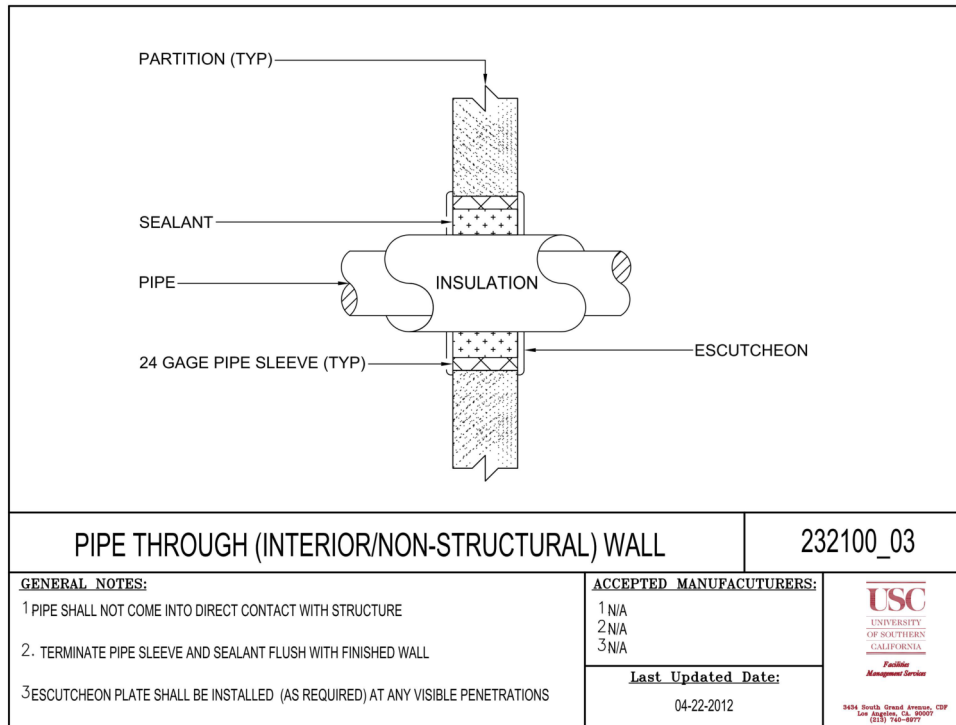
Pipe Size	Application (Steel to Copper Transition)	Components
	<u>Note: 12" brass nipple (single piece) between dissimilar metal pipes serve as means of separation between dissimilar metals mitigate dielectric deterioration. Avoid piping and conduit systems for different services coming into physical contact with one another.</u>	

14. Piping shall be pressure tested prior to application of insulation to any piece of the piping system.
15. Refer to 23 25 00 for requirements related to flushing and cleaning of the system.
16. Coordinate with controls contractor and install all controls instrumentation required so as to be accessible and provided with proper clearance to service and/or replace.
17. Refer to Section 23 05 19 for gage and flow meter requirements.
18. Provide rigid inserts at all pipe support points to prevent compression of insulation.
19. Provide pipe roller supports as necessary to accommodate expansion as per the design proposed under Section 23 05 16.
20. Refer to the following detail for piping at the building connection. Provide isolation valves and bypass when connecting building onto campus central hydronic piping systems in order to separate the building cleaning and flushing efforts from the site utility. Install a differential pressure sensor at building point of entry. Refer to Section 33 6000 for reference:

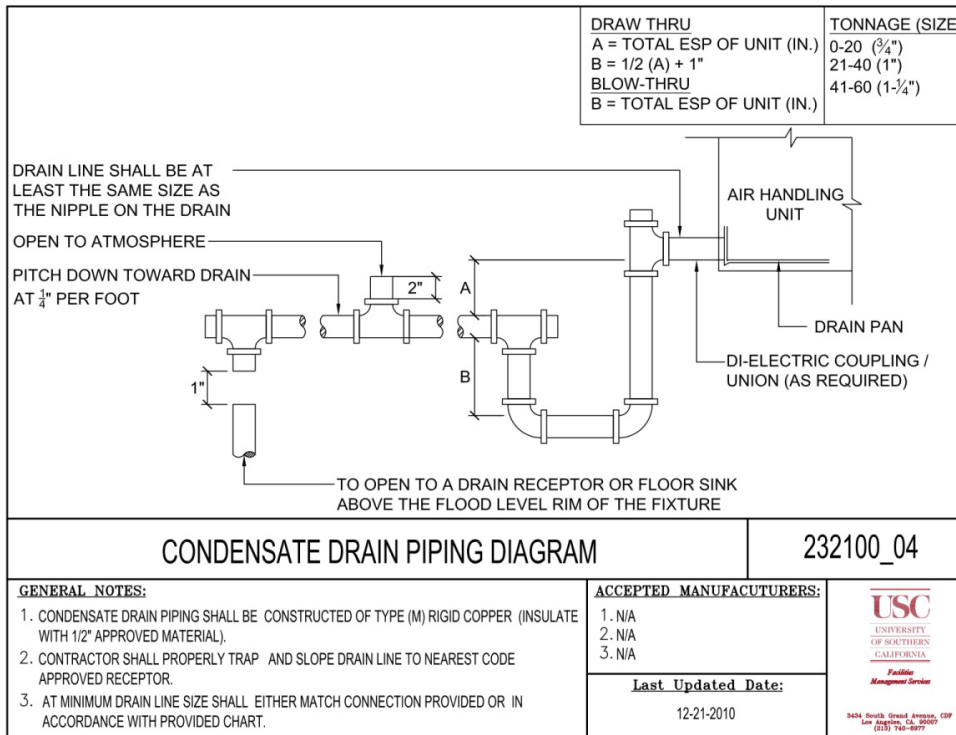


21. Refer to and follow the detail for pipe penetrations through walls:

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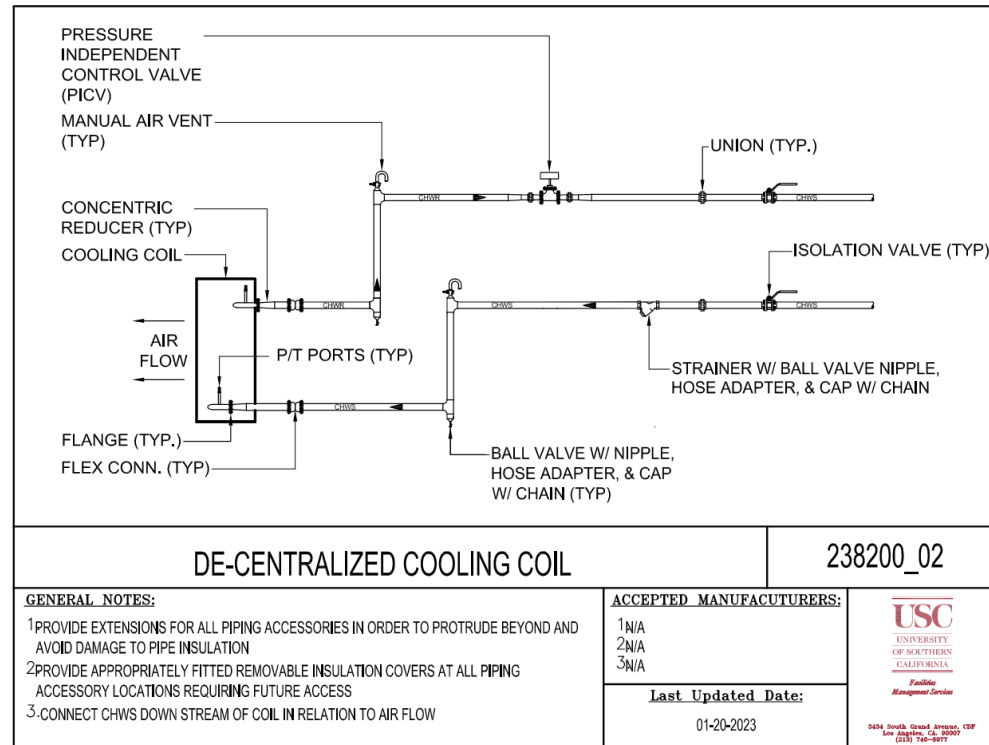
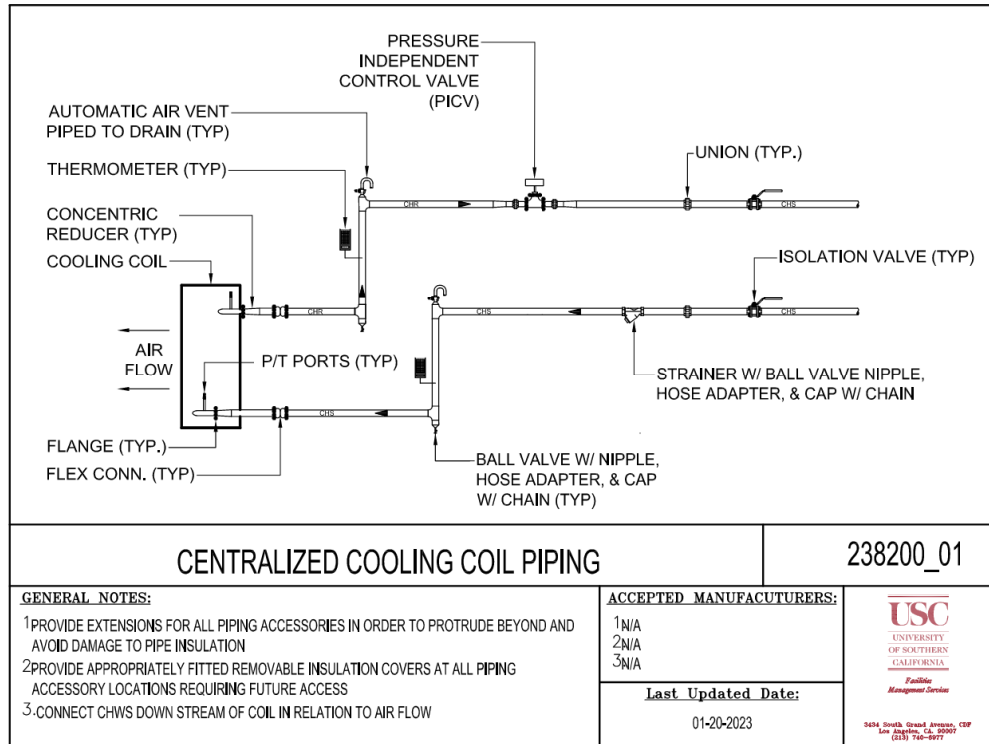


22. Refer to and follow the detail below for condensate drain piping:



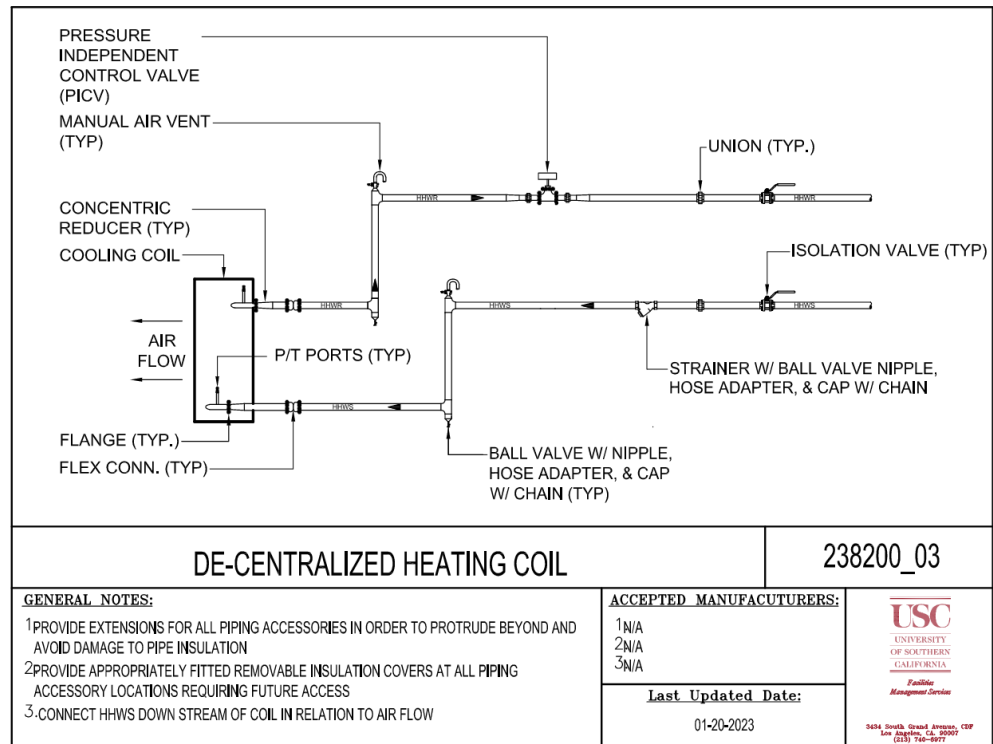
23. Refer to and follow the details below for cooling coil piping:

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24. Refer to and follow the detail below for heating coil piping:

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25. Pipes shall have their ends kept capped and be stored on pallets until the point at which the pipe is installed in its final location. When the pipe is installed in its final location, it shall have a temporary plastic cap put in place whenever active construction is not requiring access to the open end.
26. For manual and automatic air vents, provide dielectric fitting for dissimilar metals per Item #13 Dielectric Isolation Assembly Table above.

**B. Preferred:**

1. Provide 45° fittings for changes of direction in the vertical plane, when possible, otherwise use right angle (90°) fittings.
2. Distribute main utility pipe headers in corridors or common areas for ease of access outside of occupied spaces
3. Weldolets and Threadolets are acceptable. Hot tapping is allowed under very specific circumstances and shall be considered on a case-by-case basis (approval shall be obtained from FPM Facilities).
4. Branch piping connections should be made at top of piping mains to avoid sediment buildup within vertical branch piping connections.

**C. Disallowed:**

1. Stab-in welded pipe or t-drill branch tees are not allowed.
2. Bull head fitting connections are not allowed.
3. Distribution of piping systems through electrical or telecommunication utility rooms is not allowed, unless to provide service to HVAC system designed to control temperature of these rooms.
4. Flexible pipe isolators are not to be used as a means of correcting the misalignment of piping and shall not exceed 12 inches in length.

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5. Pro-press, or similar, type fittings are not allowed.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required items: Hydrostatic Pressure Testing. Coil balancing report. See also Cleaning and Passivation requirements in 23 25 00.
- B. Documentation required:
  1. Test reports: Hydrostatic Pressure Testing. Coil balancing report.
  2. Commissioning report.
- C. Required testing protocols beyond normal Commissioning and TAB protocols:
  1. Hydrostatic Testing Procedures:
    - a) Use ambient temperature water as a testing medium.
    - b) While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
    - c) Isolate expansion tanks and cooling towers and determine that hydronic system is full of water.
    - d) Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure, but meeting code requirements as noted below. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
    - e) As indicated in 2010 California Mechanical Code Section 1201.2.8, piping shall be tested with a hydrostatic pressure of not less than 100 psig, but at least 50psig greater than operating pressure. Required tests shall be conducted by the owner or contractor in the presence of an authorized inspector. The piping being tested shall remain exposed to the inspector and shall not leak during the test.
    - f) After hydrostatic test pressure has been applied for at least 2 hours, examine piping, joints and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
    - g) Prepare written report of testing to Owner's Representative, including description of repairs made. Include test Bristol recording.

**END OF DOCUMENT**



# USC DESIGN GUIDELINES

## 23 2116 HYDRONIC PIPING SPECIALTIES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Safety valves and pressure vessels shall bear the appropriate ASME label.
      - 1) Expansion tanks: Boiler and Pressure Vessel Code: Section VIII, Division 1.
      - 2) Safety Valves
      - 3) Pressure Reducing Valves
    - b) Provide manual air vents at all system high points and de-centralized hydronic coil connections.
    - c) Provide automatic air vents at all centralized hydronic coil connections or other hydronic systems exposed and located in service/equipment rooms.
    - d) Provide air separators and expansion tanks on all chilled water and heating hot water systems.
    - e) Provide proper sloping for positive drainage of system, associated low points shall be identified on documents.
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None required

### 3. PRODUCT REQUIREMENTS

- A. Air Separator:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Bell and Gossett
      - 2) Taco

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- 3) Armstrong
      - 4) Spirotherm
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Steel, tested and stamped in accordance with ASME Section VII
      - 2) Tangential inlet and outlet connections, internal stainless steel air collector tube.
    - b) Preferred:
      - 1) Integral strainer
    - c) Disallowed: None
- B. Expansion Tank:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Bell and Gossett
      - 2) Wessels
      - 3) Taco
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with National Board Form U-1, rated for working pressure
      - 2) Flexible butyl diaphragm sealed into tank
      - 3) Pressure gage and air-charging fitting, tank drain
    - b) Preferred: No preferences
    - c) Disallowed: None
- C. Flow-Limiting Valves:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Griswold
      - 2) Delta P (control valve with built-in flow limiting device)
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Valves may be incorporated into circuit control valves or shall otherwise be pressure independent type.
      - 2) Provide the following flow limiting devices for water balance of the individual circuits for air coils:

System Size	System Coil Type	Flow Limiting Device
< 40 gpm	De-centralized coils	Spring loaded Griswold (automatic) type controller
≥ 40 gpm	Centralized AHUs	Delta P controller – separate flow limiting device not required

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- b) Preferred: No preferences
  - c) Disallowed: None
- D. Calibrated Balancing Valves:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) TA Hydronics
      - 2) Bell and Gossett
      - 3) Taco
      - 4) Armstrong
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Pressure dependent circuit-setter type balancing valves
      - 2) All balancing valves shall include a concealed memory with a locking tamperproof setting.
      - 3) All balancing valves shall be furnished with valve manufacturer's preformed rigid polyurethane thermal insulation and extended level stem.
    - b) Preferred: No preferences
    - c) Disallowed: None
- E. Safety Pressure-Relief Valves:
- 1. Manufacturers:
    - a) Required:
      - 1) If the safety relief valve comes as an on-board or field-installed accessory to a piece of protected equipment provided by the equipment manufacturer, there is no specific manufacturer requirement.
    - b) Preferred:
      - 1) Watts
      - 2) Kunkle
      - 3) Consolidated
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) For heated liquids and gases.
      - 2) ASME certified and labeled.
      - 3) Bronze body, Teflon seat, stainless steel valve spring and trim, automatic direct pressure actuated
      - 4) Valves suitable and rated for proper temperatures; for "safety relief valves" minimum temperature rating is saturated steam temperature corresponding to pressure 10 percent higher than valve set pressure.
      - 5) Valves shall have set pressure indicated but not more than working pressure of protected equipment.
      - 6) Valves shall open, under test, at set pressure, with tolerance of plus or minus 2 psi for set pressures up to 70 psig and plus or minus 3 percent for set pressures in excess of 70 psig.

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- 7) Valves shall have capacity to relieve maximum possible generated energy while maintaining pressure in protected equipment at no more than 10 percent above vessel working pressure.
- b) Preferred: No preferences
- c) Disallowed: None

### F. Pressure-Reducing Valves:

- 1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Watts
    - 2) Kunkle
    - 3) Consolidated
  - c) Disallowed: None
- 2. Component Characteristics:
  - a) Required:
    - 1) For unheated liquids
    - 2) ASME certified and labeled.
    - 3) Bronze body, Teflon seat, stainless steel valve spring and trim, automatic direct pressure actuated
    - 4) Valves suitable and rated for proper temperatures;
    - 5) Valves shall have set pressures indicated
    - 6) Valves shall have capacity to relieve maximum possible generated energy while maintaining pressure in protected equipment at no more than 10 percent above vessel working pressure.
  - b) Preferred: No preferences
  - c) Disallowed: None

### G. Drain Valves:

- 1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Nibco
    - 2) Crane
    - 3) Grinnell
    - 4) Apollo
  - c) Disallowed: None
- 2. Component Characteristics:
  - a) Required:
    - 1) For sizes up to 3", ball valve with lever handle hose bibb, cap and chain. For sizes larger than 3", butterfly valve with flanged opening.
    - 2) Size as follows:

Line size	$\frac{3}{4}$ to $1 \frac{1}{4}$	$1 \frac{1}{2}$	2	3	4	6	8
Drain size	$\frac{3}{4}$	1	$1 \frac{1}{4}$	$1 \frac{1}{2}$	2	2	2

- b) Preferred: No preferences
- c) Disallowed: None

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- H. Manual Air Vents:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Nibco
      - 2) Crane
      - 3) Grinnell
      - 4) Apollo
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) 3 inch tall vertical sections of 2 inch diameter pipe to form air chamber, with 1/4 inch ball valve at top of chamber with hose bibb and cap.
    - b) Preferred: No preferences
    - c) Disallowed: None
- I. Automatic Air Vents:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Bell and Gossett
      - 2) Taco
      - 3) Armstrong
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Brass or semi-steel body, solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure.
    - b) Preferred: No preferences
    - c) Disallowed: None
- J. Strainers:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) O.C. Keckley Company.
      - 2) Mueller.
      - 3) Spirax Sarco.
      - 4) C.M. Bailey.
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide drain line, with hose bibb, cap and chain.
      - 2) Provide the following materials and joints:

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Service	Valve Type	Size	Material	Joining Method
Chilled Water (CHW)	Strainers	≤2"	Bronze	Threaded
Heating Hot Water (HHW)		>2 ½"	Steel	Flanged
Condenser Water (CDW)	Strainers – Basket Type (CDW only)	All	Steel	Flanged

- b) Preferred: No preferences
- c) Disallowed: None

### K. Check Valves:

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Nibco
    - 2) Crane
    - 3) Hammond
    - 4) Milwaukee
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Provide the following materials and joints:

Service	Valve Type	Size	Material	Joining Method
Chilled Water (CHW)	Swing Check Valve	≤2"	Bronze	Threaded
Heating Hot Water (HHW)		>2 ½"	Steel or Cast Iron	Flanged
Condenser Water (CDW)	Non-Swing Check Valve	≤2"	Bronze	Threaded
		>2 ½"	Steel or Cast Iron	Flanged

- b) Preferred: No preferences
- c) Disallowed: None

### L. Pump Suction Diffusers:

1. Manufacturers:
  - a) Required:
    - 1) Match to pump manufacturer.
  - b) Preferred:
    - 1) Design and install systems so as to not require pump suction diffusers.
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Angle type body with carbon steel inlet straightening vanes and carbon steel combination Diffuser-Strainer-Orifice Cylinder with 3/16

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inch diameter strainer openings for pump protection. Permanent magnet located within flow stream removable for cleaning. Equip orifice cylinder with disposable 16 mesh bronze start-up strainer. For condenser water pumps use stainless steel strainers.

- 2) Orifice cylinder to withstand pressure differential equal to pump shutoff head. Free area to be five times cross section area of pump suction opening. Vane length no less than 2-1/2 times pump connection diameter.
  - 3) Adjustable support foot to carry weight of suction.
  - 4) Pump suction diffusers are only allowed when a separate strainer is provided on the inlet piping of pump. Refer to Section 23 21 23 for detail.
- b) Preferred: No preferences  
c) Disallowed: None

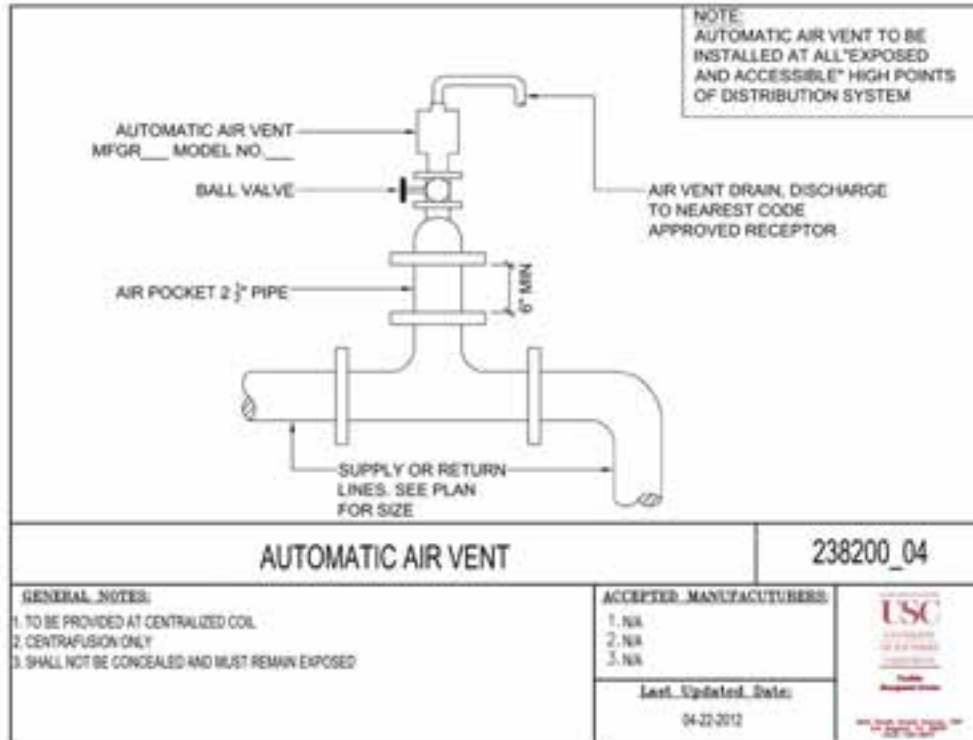
### 4. INSTALLATION REQUIREMENTS

- A. Required:
1. Automatic air vents shall be piped and discharged at nearest approved receptor.
  2. Provide devices at a minimum at following locations:

Device Type	Required Locations	Comments
Automatic Air Vents	<ol style="list-style-type: none"> <li>1. At centralized air-handlers only</li> <li>2. At all high points where exposed within a mechanical room or roof and can be properly discharged to a receptor.</li> </ol>	Pipe to plumbing receptor.
Flow-Limiting Valves	<ol style="list-style-type: none"> <li>1. At each piece of equipment having a modulating control valve.</li> </ol>	
Calibrated Balancing Valves	<ol style="list-style-type: none"> <li>1. At each floor level branch from risers on return leg.</li> </ol>	
Drain Valves	<ol style="list-style-type: none"> <li>1. At low points leaving each piece of equipment</li> <li>2. At each floor level branch from risers</li> <li>3. At all low points in piping</li> <li>4. At least one per isolated section caused by shut-off valve placement</li> </ol>	At bottom of riser: provide full line size.
Manual Air Vents	<ol style="list-style-type: none"> <li>1. At high points leaving each piece of equipment</li> <li>2. At each floor level branch from risers</li> <li>3. At all high points in piping</li> <li>4. At least one per isolated section caused by shut-off valve placement</li> </ol>	

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3. Refer to the detail on the following page for automatic air vent installation:



B. Preferred: No preferences

C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Expansion tank, Pressure relief/ Pressure reducing valves.

B. Documentation required:

1. Test reports: Testing, Adjusting and Balancing.
2. Commissioning report.
3. ASME label or stamp: Expansion Tanks, Pressure Reducing Valves, Safety Relief Valves

C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**



# USC DESIGN GUIDELINES

## 23 2123 HYDRONIC PUMPS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13 and Section 23 21 16.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Specify closed coupled, end suction pumps for ranges of 5 Hp or less.
    - b) Base mounted, end suction, coupled pumps shall be used. Select automatic condensate pump to overcome estimated pressure drop to anticipated condensate point of termination.
    - c) Provide on documents if automatic condensate pump is integral to unit/equipment they serve or specified separate to associated equipment and whether powered through unit/equipment they serve or powered independently.
  - 2. Preferred:
    - a) Base mounted, end suction, coupled pumps should be selected to provide efficiency of 75% or greater.
  - 3. Disallowed:
    - a) Do not specify pumps with impellers exceeding 90% of the impeller diameter range for the pump casing.
    - b) Triple-Duty valves are not allowed.
    - c) Pump suction diffusers are not allowed by design and may only be used when field conditions require it, as approved by USC.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Pumps shall have a BIM family provided within the BIM model, inclusive of motor information.

### 3. PRODUCT REQUIREMENTS

- A. Hydronic Pumps:

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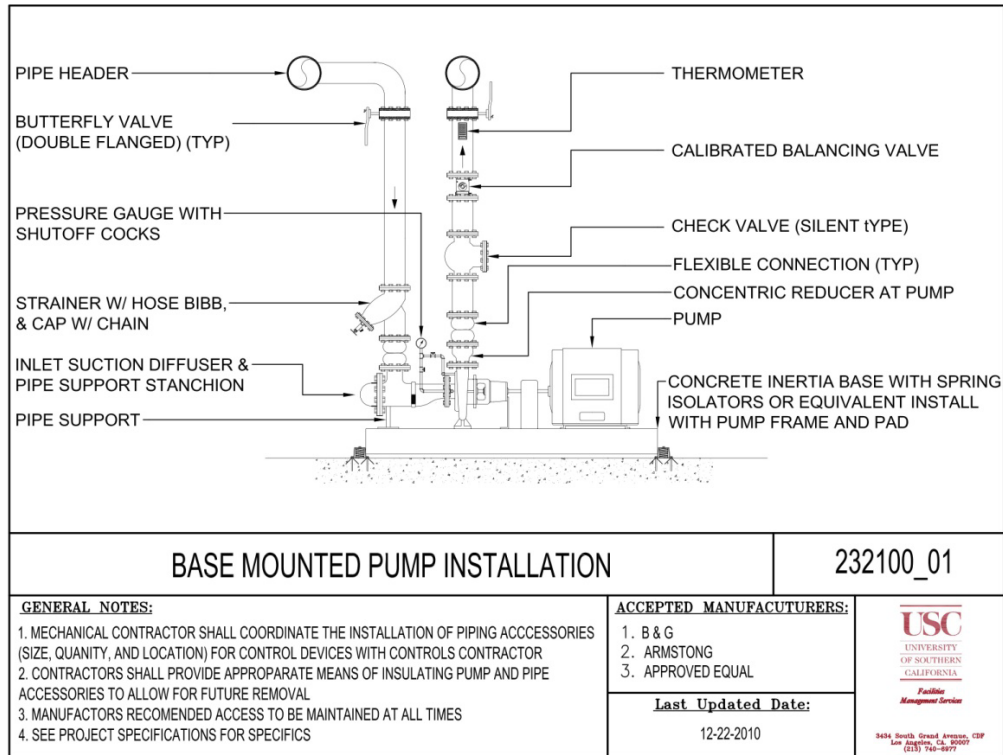
1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Bell and Gossett
    - 2) Armstrong
2. Component Characteristics:
  - a) Required:
    - 1) Provide coupled pumps with manufacturer's standard steel base.
    - 2) Provide mechanical type seals.
  - b) Preferred: 1800 RPM Motors are preferred, but if necessary for design reasons 3600 RPM motors, may be acceptable, when it can be justified by project design requirements.

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  1. Suction piping shall be at least one pipe size larger than pump section.
  2. Install eccentric reducers for all horizontal suction piping at inlet of pump.
  3. Install piping to allow 5 diameter straight length of pipe before connecting to pump suction end.
  4. Install piping and valves so that pump suction and discharge pressures may be read from a single pressure gage.
  5. Install pump so removal can be accomplished without significant piping disassembly.
  6. Install using flexible type coupling with EPDM sleeve, solid foot mounted volute.
  7. Entering and leaving flanges shall be drilled and tapped for gage connections.
  8. Installation requirements for Automatic Condensate Pumps:
    - a) Install pump on level support.
    - b) Locate pump inlet lower than condensate pan discharge connection.
    - c) Install pump in location maintaining adequate service clearances.
    - d) Install pump to allow for simple removal or repair of existing or replacement of pump unit.
  9. Pump control packaged systems which are independent from the base building automation system shall be provided.
  10. Pumps shall be properly re-aligned in the field as part of start-up with activities noted in the dynamic balancing test report.

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11. Refer to and follow the detail for base mounted pump installation, paying special attention to the pipe support's anchorage to the isolated base system:



- B. Preferred: No preferences
- C. Disallowed: Flexible pipe isolators are not to be used as a means of correcting the misalignment of piping.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Pumps.
- B. Documentation required:
  1. Testing, Adjusting and Balancing Reports
  2. Commissioning report.
  3. Dynamic balancing Test Report
  4. In-person witnessing: Visual proof of water drainage at end of automatic condensate pump discharge pipe.
  5. UL listing: All pumps.
    - a) Automatic condensate pump and enclosure to meet UL listing code requirements, if unit is not integral to unit/equipment they serve.
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 2213 STEAM AND CONDENSATE HEATING PIPING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 05 16, 23 21 13, 23 21 16, 33 60 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

- D. Additional Information:
  - 1. For the purpose of this guideline, this section pertains to the following services: steam and steam condensate piping.
  - 2. General requirements for all HVAC-related piping shall be as noted in Section 23 21 13. This section covers only clauses unique to steam-related piping.
  - 3. Refer to the delegated design responsibilities for control of expansion as noted in Section 23 21 16 and submit to FPM Engineering as required.
  - 4. Coordinate with the work of Section 33 60 00 for main steam and steam condensate entry to the building. Building engineer shall be responsible to provide appropriate anchorage and expansion to be consistent with section 23 05 16 but taking into account what residual forces and expansion may be occurring in the outdoor buried installation. Link-Seal at the entry point shall account for the outdoor buried pre-fabricated pipe remaining insulated and passing into the building. Link-Seal shall be provided under this Section and its specification shall be appropriate to the temperature of the carrier pipe (i.e a high temperature Link-Seal option should be used for steam). The buried pipe extension into the building shall be provided under Section 33 60 00 scope of work.

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) New piping systems shall be designed to avoid exceeding the pressure drop and velocity criteria at specified locations as listed in the table below. Existing piping systems affected by retrofit shall maintain the current velocity in the system (by calculation) or meet the criteria noted below, whichever is greater. Refer to Section 23 00 00 for testing “pre-read” requirements for retro-fit applications.

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Piping Location	Pressure Drop`	Velocity
Building laterals from site utility source	2 feet / 100 feet	4000FPM
Building risers and floor / level main headers	3 feet / 100 feet	4000FPM
Equipment branches / circuits or sub-headers	4 feet / 100 feet	4000FPM

- b) Pre-manufactured / Pre-packaged valve sets with combination valves or configurations that cannot be field-dismantled are not allowed. This clause does not preclude pre-fabricated valve sets built up out of individual components separated with flanges or unions.
  - c) Only 90 degree fittings/transitions shall be used for steam piping and the elbows shall be of long-radius type.
2. Preferred: No preferences
3. Disallowed:
- a) No 45 degree fittings/ transitions allowed for steam piping.
  - b) Compressed air leakage testing of carrier piping.

B. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS

A. Above ground HVAC piping:

- 1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred: No preferences
  - c) Disallowed: None
- 2. Component Characteristics:
  - a) Required:
    - 1) Provide the following materials for piping and fittings:

Service	Size	Material	Joining Method
Steam	All	ASTM A53 Type S (Seamless) Schedule 40 Black Steel Domestic Source	Welded
Steam Condensate	All	ASTM A53 Type E Schedule 80 XS (Extra Strong) Black Steel Domestic Source	Welded

- 2) Provide the following grading and slope criteria for drainage and venting:

Piping Type	Slope	Direction of Fall
Steam (runout to equipment)	1" per 10'-0"	Back to mains

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Piping Type	Slope	Direction of Fall
Steam (main)	1" per 10'-0"	Down in direction of flow

- b) Preferred: No preferences
- c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Refer to Section 23 21 13 for general piping requirements.
  - 2. Special attention must be paid to the sloping and trapping of steam lines. Slope in the direction of steam flow. Provide drip legs as necessary at all low points, drops to equipment and lifts in piping elevation.
  - 3. See Section 23 22 16 for steam specialties, including traps.
  - 4. Provide rigid pipe inserts at all pipe supports in order to prevent compression of insulation.
  - 5. Provide pipe roller supports as necessary to accommodate expansion as per the design proposed under Section 23 05 16.
  - 6. All steam utilizing equipment shall be mounted / raised at proper height, so as to allow for trap discharge lines (low pressure condensate) to drain by gravity to nearby designated condensate receiver.
- B. Preferred:
  - 1. Refer to Section 23 21 13 for general piping requirements.
- C. Disallowed:
  - 1. Refer to Section 23 21 13 for general piping requirements.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
None
- B. Documentation required:
  - 1. Test reports: Pressure Testing per 23 21 13.
  - 2. Hydronic Cleaning per Section 23 25 00
- C. Required testing protocols beyond normal Commissioning and TAB protocols:
  - 1. Pressure Testing per 23 21 13.
  - 2. Hydronic Cleaning per Section 23 25 00.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 2216 STEAM AND CONDENSATE PIPING SPECIALTIES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Sections 23 05 23, 23 22 13, 23 22 23 and 23 21 13. For steam and condensate meters, refer to independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Safety valves and pressure vessels shall bear the appropriate ASME label per Boiler and Pressure Vessel Code: Section VIII, Division 1.
      - 1) Safety Valves
      - 2) Pressure Reducing Valves
    - b) The specialties shall be rated for pressure equal to the pressure of the piping system to which it is attached and safety valves shall be sized as required benchmarked against the associated equipment's normal operating pressure and input capacity.
    - c) Design documents shall state the minimum working pressures, temperatures and safety valve setpoints for each system.
    - d) Provide steam trap monitoring stations and system, similar to Spirax Sarco SPIRA-tec Sensor Chamber. Discuss with FPM Facilities on monitoring method options: Local read-out vs. Interface with EMS/BMS.
    - e) Only 90 degree fittings/transitions shall be used for steam piping and the elbows shall be of long-radius type.
  - 2. Preferred:
    - a) It is preferred that flash tanks be avoided for low pressure systems (below 15 PSI) and that a vented receiver at the steam condensate recovery pump be used.
    - b) Where possible, consideration should be given for the re-use of flash steam prior to venting.
    - c) Where central steam utility is provided for the purpose of serving more than space heating building loads (for example, domestic and industrial hot water heating, an appropriate meter and accompanying instrumentation, shall be provided, in order to attain the full building steam demand, in an effort to measure and monitor energy in terms of BTUs.

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3. Disallowed:  
 a) No 45 degree fittings/ transitions allowed for steam piping.

B. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS

A. Specialties:

1. Manufacturers:

- a) Required: No requirements.  
 b) Preferred:  
 1) Spirax Sarco (in particular, Spirax Sarco steam traps are preferred)  
 2) Armstrong  
 3) Watts  
 4) Kunkle Valve  
 5) Hoffman Specialties.

c) Disallowed: None.

2. Component Characteristics:

a) Required:

- 1) Provide the following materials and joints for the following valves:

Service	Valve Type	Size	Material	Joining Method	
High Pressure Steam (HPS)	Strainer	All	Steel	Screwed or Flanged	
Steam Condensate (CR)					
Low Pressure Steam (LPS)	Check	≤2"	Cast Iron	Screwed	
Steam Condensate (CR)		≥2 ½"	Steel	Flanged	
		Strainer	≤2"	Steel	Screwed
		Strainer	≥2 ½"	Steel	Flanged

- 2) The following specialties shall be used:

Y pattern strainers	250 CWP rating Stainless steel mesh Blow off plug	Threaded ends 2" and below, flanged ends for larger sizes. Provide blowdown connection with drain line, hose bibb, cap and chain.
Basket strainers	250 CWP rating Stainless steel mesh	Threaded ends 2" and below, flanged ends for larger sizes. Provide blowdown connection with drain line, hose bibb, cap and chain.



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Bronze safety valves	Class 250, forged copper alloy disc, fully enclosed steel spring	Threaded connections, adjustable pressure range and positive shutoff, factory set and sealed.
Cast-iron safety valves	Class 250, forged copper alloy disc with bronze nozzle, fully enclosed cadmium-plated steel spring	Raised flange connections, adjustable pressure range and positive shutoff, factory set and sealed.
Drip Pan Elbow	Cast iron complying with ASME B1.20.1	Threaded inlet and outlet
Pressure reducing valves	Pilot-actuated, diaphragm type, cast iron with hardened stainless steel trim, non-asbestos gasket material.	Threaded ends 2" and below, flanged ends for larger sizes, adjustable pressure range and positive shutoff Factory set for inlet and outlet pressures.
Float and thermostatic traps	Cast iron with bolted cap, balanced pressure type, stainless steel head and seat, stainless steel bellows, with vacuum breaker.	Threaded connections, capable of withstanding 45°F of superheat and resisting water hammer without sustaining damage. Provide with trap monitoring system.
Inverted bucket traps	Cast iron, stainless steel head and seat, stainless steel bucket, integral strainer. Stainless steel thermostatic air vent.	Threaded connections. Provide with trap monitoring system.
Thermostatic air vents	Stainless steel body, stainless steel float, valve and seat. Phosphor bronze bellow in stainless steel cage	Threaded connections
Vacuum breakers	Stainless steel body, stainless steel sealing ball, retainer, spring and screen.	Threaded connections
Flash tanks	150 psig	Taps for low pressure steam and condensate outlets, high pressure condensate inlet, air vent and safety valve

- b) Preferred: No preferences.
- c) Disallowed: None.

B. Flexible Connectors:

1. Manufacturers:

- a) Required: No requirements.
- b) Preferred:

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- 1) Hyspan Precision Industries
- 2) Mason Industries
- 3) Metraflex Company
- c) Disallowed: None.
- 2. Component Characteristics:
  - a) Required:
    - 1) Stainless steel bellows with woven, flexible bronze wire-reinforced protective jacket
    - 2) Capable of 3/4 inch misalignment.
    - 3) Threaded or flanged connections to match equipment requirements.
  - b) Preferred: No preferences.
  - c) Disallowed: None.

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Specialties shall be installed at the following locations:

Shut off valves	At Branch connections At Steam supply connections At outlet of steam traps Upstream of each dielectric fitting.	Install unions at valves 2" and small, flanges for larger pipe sizes
Strainers	At supply side of control valves Upstream of pressure reducing valves At steam traps	Install 3/4" nipple and full port ball valve in blowdown connection for strainers 2" and large, match pipe size for smaller sizes
Safety valves	Downstream of pressure-reducing valve	Pipe discharge piping without valves to nearest floor drain. For valves larger than 2.5", install exhaust head with drain to waste.
Drip Pan Elbow	Adjacent to safety valve	Pipe drain connection to nearest floor drain.
Pressure reducing valves	At pressure-reducing stations	Pipe discharge piping without valves to nearest floor drain. Install unions or flanges and gate valves on both sides of valve. Provide bypass piping around pressure-reducing valve with globe valve equal in size to area of pressure reducing valve seat ring.
Float and thermostatic trap – for all heat	As close as possible to connected equipment	Install full port ball valve, strainer and union upstream of trap, union,

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exchangers, modulating equipment and low pressure drip legs		check valve and full port ball valve downstream
Inverted bucket steam traps – for all high pressure drip legs	As close as possible to connected equipment	Install full port ball valve, strainer and union upstream of trap, union, check valve and full port ball valve downstream
Control valves	At supply to equipment	Install bypass piping with globe valve around control valve. If parallel control valves are provided, only one bypass is required
Vacuum breakers	Downstream from control valve	Install close to equipment inlet connection.
Flash tanks	Use for high pressure steam systems only	Provide venting directly to outdoors.
Check Valves	Downstream from steam traps, yet prior to isolation valve on condensate side.	

- B. Preferred:
  - 1. Strainers on steam systems to be installed in a horizontal configuration, so as to avoid potential accumulation of condensate a low point in piping system.
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Safety Valves, Pressure Reducing Valves
- B. Documentation required:
  - 1. ASME label and listing: Safety Valves, Pressure-Reducing Valves
- C. Required testing protocols: None

**END OF DOCUMENT**

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## 23 2223 STEAM CONDENSATE PUMPS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13, 23 21 16, 23 22 13 and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Refer to Section 33 60 00 for back pressure requirements to overcome campus steam condensate return system.
    - b) All steam condensate pumps shall be a Griswold-type flow control valve to limit the flow independent of pressure.
  - 2. Preferred: No preferences
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Pumps shall have a BIM family provided within the BIM model, inclusive of motor information.

### 3. PRODUCT REQUIREMENTS

- A. Steam condensate pump:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Hoffman
      - 2) Roth
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Requirements:

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- 1) Packaged duplex-type with common base, with vented receiving tank, requested accessories and controls.
- 2) Pump shall be bronze fitted throughout and rotating parts dynamically balanced.
- 3) Motors shall be 1750 rpm whenever possible.
- 4) Unit shall be furnished with condensate and air discharge valves, vacuum relief valve, compound gage, thermometer and companion connection flanges.
- 5) Pump shall be close-coupled with strainer and bronze isolation valve between receiver and pump.
- 6) Receiving tank shall be cast iron with inlet strainer, gage glass, air discharge separator and automatic ball float operated valve.
- 7) Provide single power connection point.
- 8) Provide electric alternators (or other acceptable control means) to automatically transfer operating sequence of pumps. Entire controller shall be a UL rated assembly.
- 9) Provide float type level switches for mid and high level alarms. Local alarm annunciation and alarm silencing shall be provided.
- 10) Provide separate mid and high level alarm dry contacts for building automation system.
- 11) Overflow from receiver / condensate pump shall be coordinated and piped to nearby approved receptor.
  - b) Preferred: No preferences
  - c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  1. Pumps shall be mounted on a minimum 6" high pad.
  2. Pumps shall be located with adequate clearances for regular service and future replacement.
  3. Receiver shall be properly vented to atmosphere, the final termination of which shall be coordinated to assure no injury to persons or damage to property.
- B. Preferred:
  1. Receiver to be distributed up throughout building and vented to nearest roof level, and terminated in such a way, so to assure no injury to persons or damage to property.
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Steam Condensate Pumps.
- B. Documentation required:
  1. Test reports: Testing Adjusting and Balancing.
  2. Commissioning report.
  3. UL listing: Steam condensate pumps.

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- C. Required testing protocols beyond normal Commissioning and TAB protocols: None.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 2300 REFRIGERANT PIPING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Sections 23 81 23, 23 81 26 and 23 81 45.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X		X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Size piping and design actual piping layout, including oil traps, double risers, specialties and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator and length of piping to ensure proper operation and compliance with warranties of connected equipment.
    - b) Comply with the following standards:
      - 1) Welding: ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
      - 2) ASHRAE 15, "Safety Code for Refrigeration Systems."
      - 3) ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
      - 4) Liquid Accumulators: Comply with ARI 495.
      - 5) Receivers: Comply with ARI 495, ASME Boiler and Pressure Vessel Code, UL 207.
      - 6) Permanent Filter Dryers: Comply with ARI 730.
      - 7) Replaceable-Core Filter Dryers: Comply with ARI 730
      - 8) Hot-Gas Bypass Valves: Comply with UL 429
      - 9) Thermostatic Expansion Valves: Comply with ARI 750.
      - 10) Solenoid Valves: Comply with ARI 760 and UL 429;
      - 11) Safety Relief Valves: ASME Boiler and Pressure Vessel Code, UL 207.
    - c) Select system components with pressure rating equal to or greater than system operating pressure, ensuring that they will withstand the required test pressure. Refer to Section 5.
  - 2. Preferred:
    - a) No preferences.
  - 3. Disallowed:

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- a) Refrigerant R-22 is not allowed for new equipment and only recycled R-22 may be used to recharge older equipment.
- b) Pre-manufactured line sets are not allowed.

B. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS

A. Piping:

- 1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred: No preferences
- 2. Component Characteristics:
  - a) Required:
    - 1) Piping shall be as follows:

Service	Size	Material	Joining Method
Liquid, Hot-gas and Suction lines for air-conditioning and heat pump applications	≤2"	Copper, ACR, drawn-tempered tubing and wrought-copper fittings	Brazed
	>2"	Schedule 40, black-steel	Welded
Safety Valve Relief discharge (for chiller vent applications)	≤2"	Copper, ACR drawn-tempered tubing and wrought-copper fittings	Soldered
	>2"	Schedule 40, black-steel	Welded

- b) Preferred: No preferences.
- c)

### 4. INSTALLATION REQUIREMENTS

A. Required:

- 1. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.
- 2. Install refrigerant piping in protective conduit where installed belowground. Provide an installation detail, for underground installation, within plans.
- 3. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- 4. Slope refrigerant piping as follows:
  - a) Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - b) Install horizontal suction lines with a uniform slope downward to compressor.
  - c) Install traps and double risers to entrain oil in vertical runs.
  - d) Liquid lines may be installed level.
- 5. Install piping free of sags and bends.
- 6. Install fittings for changes in direction and branch connections.



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7. Adjust thermostatic expansion valve to obtain proper evaporator superheat, high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure and set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
8. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  - a) Open shutoff valves in condenser circuit.
  - b) Verify that compressor oil level is correct.
  - c) Open compressor suction and discharge valves.
  - d) Open refrigerant valves except bypass valves that are used for other purposes.
  - e) Check open compressor-motor alignment and verify lubrication for motors and bearings.
9. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.
10. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
11. Install the following specialties as noted:

Compressor	<ul style="list-style-type: none"> <li>- Angle valves in suction and discharge lines</li> <li>- Strainer upstream</li> <li>- Filter dryers in liquid line between compressor and thermostatic expansion valve and in the suction line at the compressor</li> <li>- A check valve at the compressor discharge and a liquid accumulator at the compressor suction connection</li> <li>-</li> </ul>
Filter dryers	<ul style="list-style-type: none"> <li>- Angle valves on inlet and outlet side</li> <li>- Full-sized, three-valve bypass</li> </ul>
Strainers	<ul style="list-style-type: none"> <li>- Service valves for gage taps at inlet and outlet</li> </ul>
Thermostatic expansion valve	<ul style="list-style-type: none"> <li>- Solenoid valves upstream</li> <li>- Moisture/liquid indicators in liquid line at the inlet</li> <li>- Strainer upstream</li> <li>- As close as possible to distributors on evaporators.</li> <li>- Install valve so diaphragm case is warmer than bulb. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps.</li> </ul>
Hot-gas bypass valve	<ul style="list-style-type: none"> <li>- Solenoid valves upstream</li> <li>- Strainer upstream</li> <li>- Service valves for gage taps at inlet and outlet</li> </ul>
Solenoid valve	<ul style="list-style-type: none"> <li>- Strainer upstream</li> <li>- Install solenoid valves in horizontal lines with coil at top</li> </ul>
Receivers	<ul style="list-style-type: none"> <li>- Size to accommodate pump-down charge</li> </ul>

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- B. Preferred: No preferences
- C. Disallowed:
  1. Do not apply heat near specialties and the expansion-valve bulb when soldering or brazing. Remove solenoid-valve coils, sight glasses, valve stems, seats and packing and accessible internal parts of refrigerant specialties.
  2. Bends shall be accomplished by fittings: bends in tubing are not allowed.
  3. Do not mount expansion valve bulb in a trap or at bottom of the line.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Piping Pressure Test and Charging
- B. Documentation required:
  1. Test reports: Pressure test/ leakage test results.
  2. Commissioning report.
  3. UL listing: Receivers, Hot-Gas Bypass Valves, Solenoid Valves
  4. ASME Pressure Vessel Testing report: Safety relief valve, receivers,
- C. Required testing protocols:
  1. Comply with ASME B31.5, Chapter VI.
    - a) Test refrigerant piping, specialties and receivers. Isolate compressor, condenser, evaporator and safety devices from test pressure if they are not rated above the test pressure.
    - b) Test high- and low-pressure side piping of each system separately at not less than the pressures indicated below.

Refrigerant	R-22	R-134a	R-407C	R-410A
Suction lines for Air Conditioning	185 psig	115 psig	230 psig	300 psig
Suction Lines for Heat Pumps	325 psig	225 psig	380 psig	535 psig
Hot-Gas and Liquid Lines	325 psig	225 psig	380 psig	535 psig

- 1) Fill system with nitrogen to the required test pressure.
  - 2) System shall maintain test pressure at the manifold gage throughout duration of test.
  - 3) Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
  - 4) Remake leaking joints using new materials and retest until satisfactory results are achieved.
- c) Charge system using the following procedures:
- 1) Install core in filter dryers after leak test but before evacuation.
  - 2) Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.

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- 3) Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
- 4) Charge system with a new filter-dryer core in charging line.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 2500 (HVAC) WATER TREATMENT

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13, 23 21 16, 23 65 00 and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

- D. Client Goals:
  - 1. For Water Treatment: Intent of this Section is to provide complete chemical treatment to protect piping systems from scale formations, corrosion, algae and slime growth in the following systems: heating hot water, chilled water, condenser water, steam and steam condensate return, steam boilers.
  - 2. For Pre-operational cleaning:
    - a) The purpose of pre-operational cleaning of newly installed mechanical systems and piping is the removal of preservatives, cutting oils, pipe dope and other contaminants prior to the injection of corrosion and deposit inhibiting chemicals and startup operation. This process is critically important to the success of the continuing water treatment program.
    - b) All cooling condenser, closed chilled, closed hot and boiler water systems and related piping shall be thoroughly flushed out with a specially formulated cleaner.
    - c) Since these types of cleaners will raise the pH of the water to which they are added, they must not be introduced to cooling towers or evaporative condensers manufactured of galvanized sheet metal as “white rust” may develop on the metal surfaces.
    - d) All newly constructed building loops must be isolated through bypass valving during the flushing and cleaning process and shall not be connected to the campus loops until the FPM Facilities has approved the passivation and treatment reports.

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Project specific procedure shall be submitted for review and compliance with FPM Facilities.

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- b) Water treatment firm shall size condenser and boiler treatment proportioning pumps feed rate to match project requirements.
  - c) Water treatment firm shall recommend sizes for the bleed manifold configuration.
  - d) Water treatment firm shall recommend sizes for the sample stream injection assembly.
  - e) All products and chemicals shall meet federal, state and local government regulations
  - f) Include in design of systems, the necessary provisions, such as additional piping, valves, and connections for temporary pumping; required for proper circulation of chemicals during water treatment.
  - g) Provisions for a LAN connection within 12” of each Aquatrac controller shall be coordinated by the appropriate design consultant and installed by the project designated and responsible telecommunications sub-contractor.
  - h) Contractor shall submit specific plan for pre-operational cleaning strategy for review. This shall include steps and temporary measures required to separate and address new versus existing piping (where applicable).
    - 1) Pre-operational cleaning plan should also take into account the implications of pressure testing (as covered under separate sections) and the goal to avoid stagnant water or corrosion in hydronic pipe systems which are not to be placed into operation immediately.
2. Preferred:
- a) Additions to existing building piping infrastructure to be isolated through permanent or temporary by-pass valving, so newly installed piping systems may be cleaned and flushed separate from existing systems.
3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Water treatment equipment shall have a BIM family provided within the BIM model, inclusive of motor and chemical content information.

### 3. PRODUCT REQUIREMENTS

- A. Water Treatment Chemicals & Service:
- 1. Manufacturers:
    - a) Required: No requirements.
    - b) Preferred:
      - 1) ChemTreat, Inc.
    - c) Disallowed: None.
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide the following chemicals and equipment (as applicable):

System	Chemicals
Condenser water treatment, open systems	<ul style="list-style-type: none"> <li>▪ ChemTreat Prod #CL- 6405 Inhibitor/pH control</li> </ul>

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	<ul style="list-style-type: none"> <li>▪ ChemTreat Prod #CL49 Microbiocide, or ChemTreat Prod #CL2212-5 Microbiocide, or ChemTreat Prod # CL2189t</li> </ul>
Closed system treatment: Chilled water, heating hot water, closed condenser water	<ul style="list-style-type: none"> <li>▪ ChemTreat Prod #BL-1821 Closed system inhibitor.</li> <li>▪ ChemTreat Prod #CT-30-5 Cleaner</li> <li>▪ ChemTreat Prod #BL-1280 &amp; CL4132 blend (specific to UPC TES system)</li> </ul>
Boiler water treatment	ChemTreat Prod #BL-122 Oxygen Scavenger ChemTreat Prod #1175 Organic Inhibitor ChemTreat Prod #BL-197 Sludge Conditioner ChemTreat Prod #BL-1301 Alkalinity Supplement ChemTreat Prod #BL-1553 Condensate Treatment

- b) Preferred: No Preferences.
- c) Disallowed:
  - 1) Chemicals shall not flow through galvanized steel cooling towers or evaporative condensers.
  - 2) High alkaline cleaner

### B. Metering Pumps, Tanks and Water Meters:

1. Manufacturers:
  - a) Required:
    - 1) All items of a given type shall be the products of the same manufacturer.
  - b) Preferred:
    - 1) Prominent
    - 2) Palsa Feeder
    - 3) LMI
    - 4) Neptune
    - 5) Clawson
    - 6) Peabody
    - 7) Carlon
    - 8) Seametrics
    - 9) Hersey
  - c) Disallowed: None.
2. System Components for Condenser and Boiler Treatment Systems:
  - a) Required:
    - 1) Water Meters: Turbine or rotating disk positive displacement type with integral pulse unit, bronze base and bronze internal carbon ball design to totalize water input in gallons with a 99 percent minimum accuracy.
    - 2) Chemical Storage systems: Provide secondary containment for all chemicals. Size tanks proportional to system tonnage or horsepower, with minimum of 50 gallons required.

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- 3) Injection assembly: Chemical injector/check valve assemblies to be supplied with each chemical pump. Stainless steel corp stops are to be provided for acid and inhibitor feeds. Solenoid valves:
  - 4) Power operated NC valves installed in condenser bleed off line.
  - 5) Motorized Ball valves: Motorized blowdown valves (min 3/4") 120vac, rated 250 psi steam for boiler blowdown.
  - 6) Coupon Racks: Each rack shall have three coupon holders. Minimum flow rate of 5gpm.
  - 7) Piping: All water treatment piping (sensors, coupon racks, etc) shall be minimum schedule 80 PVC. All chemical injection lines shall be schedule 80 CPVC.
  - 8) Brominator: Solenoid operated valve for solid bromine feed of a minimum of 5 gallons, along with necessary PVC corp stops for injection.
    - b) Preferred: No preferences.
    - c) Disallowed: None.
- C. Automatic Control Systems:
1. Manufacturers:
    - a) Required:
      - 1) Aquatrac Instruments Model # MULTI-FLEX M10T0-CP-T2-OR-F-RC for Condenser Water System (per tower).
      - 2) Aquatrac Instruments Model # MULTI-FLEX M5B-B2-TB2-RC for Boilers (to control up to 2 boilers)
    - b) Preferred: No Preferences.
    - c) Disallowed: None.
  2. Component Characteristics:
    - a) Required: No Requirements beyond model number noted above.
    - b) Preferred: No Preferences.
    - c) Disallowed: None.
- D. Bypass Feeder:
1. Manufacturers:
    - a) Required: No Requirements
    - b) Preferred:
      - 1) J.L. Wingert, Co.
    - c) Disallowed: None.
  2. Component Characteristics:
    - a) Required:
      - 1) Steel shell and heads, suitable for operating conditions up to 175 psi and 212°F.
      - 2) Cap: Cast iron with Buna N "O" ring. Quarter-turn to open, 3/4" tappings for water in and out and drain.
      - 3) For chilled water system, insulated.
      - 4) Provide 1 feeder for each closed circulating system.
    - b) Preferred: No Preferences.
    - c) Disallowed: None.

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### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. Water treatment:
  - a) Provide the following water treatment services:
    - 1) Perform analysis of water conditions.
    - 2) Supervise installation of water treatment equipment. Approve in field all system connections and feeder location before installation is begun.
    - 3) Furnish and apply all chemicals from startup thru acceptance by owner.
2. Water Meter installation: Locate in cooling tower makeup and bleed and chilled water makeup line. Note: Aquatrac will log all meter readings.
3. Coupon Racks: Install coupon rack in condenser and chilled water systems.
4. Condenser water and boiler treatment feed pumps: For each system, provide separate proportioning pumps for each chemical used. Pumps shall be mounted at height suitable for pumping chemical treatment solutions from secondary containment tanks.
5. Condenser Water Control: Provide controller interlocked with condenser water pumps to automatically control pH, conductivity and chemical feed in response to makeup, bleed off, or total dissolved solids content of water.
6. Boiler Water Treatment Controls: Provide controller interlocked with boiler on/off operation to automatically control boiler water conductivity and chemical feed in response to makeup, timed feed, or blowdown.
7. Bypass Feeder shall be installed in convenient location where it may be easily accessed. Provide approved bleed manifold with:
  - a) Solenoid bleed valve.
  - b) Manual by-pass valve.
  - c) Piping to waste.
  - d) Bleedoff rate controllable.
8. Provide accessible City water hose connection at bypass feeder system basins for cleaning and flushing.
9. Provide sample stream injection assembly.
10. Provide installation supervision and start-up of automatic water treatment systems by qualified representative of equipment manufacturer. Provide minimum of 4 hours instruction in each system operation to Owner's operating personnel.
11. Feed system piping, connections, valves, wiring, cables, controllers, and feeder locations shall be reviewed by University standard water treatment vendor and approved by FPM Facilities, prior to installation by contractor.
12. Mechanical contractor shall be responsible to direct, supply or sub-contract trade work (not including water treatment vendor) to accomplish the complete installation of all piping, connections, valves and fittings, wiring, cabling, conduit, and raceways; as necessary complete and turn over a fully functioning system.
13. Emergency shower/eyewash shall be provided at chemical treatment equipment serving Cooling Towers, Chillers, Boilers, Pumps, etc. per Los Angeles Municipal Code and OSHA 29 CFR 1910.151 requirements.



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- B. Preferred: No Preferences
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Pre-operational cleaning, FPM Facilities observation of condenser and evaporator heat exchangers.
- B. Activation and confirmation of functional LAN outlets, where provided for communication with systems covered under this section.
- C. Documentation required:
  - 1. Test reports: USC System Cleaning and Passivation Report must be completed and sent to the Project Manager prior to connection to campus utility.
  - 2. Commissioning report.
  - 3. In-person witnessing: FPM Facilities testing of water quality. Visual acceptable of condenser and evaporator heat exchanger cleanliness.
  - 4. Onsite test results: Eddy current testing of condenser and evaporator heat exchangers.
  - 5. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment. (See Preoperational Cleaning.)
  - 6. UL listing: All electric components.
- D. Required testing protocols:
  - 1. Preoperational System Cleaning
    - a) Procedures, Closed Systems:
      - 1) Once the system has been completely installed, with temporary strainers in place, the proper amounts of Trident 8002 cleaner should be added through the one shot chemical feeder. The cleaner should raise the pH of the system to 10.0-11.0.
      - 2) The cleaning solution should be circulated for 24-48 hours depending on the type of system. The success of preoperational cleaning procedures is largely dependent on flow velocities. The flow velocity should be a minimum of 5 feet per second. This velocity criterion, shall be considered when sizing of necessary by-pass piping. Please refer to further guidance provided on minimum by-pass line sizing.
      - 3) Installed pipe distribution smaller than and up to 2 inches in diameter shall have full line size by-passes provided for cleaning purposes. Installed pipe distribution of larger than 2 inches in diameter shall conform to both the minimum velocity criteria provided and the following; by-pass pipe sizing shall not fall below either 25% of the largest pipe diameter in the system, or 2 inches in diameter.
      - 4) It is very important that all control valves are open and that cleaning solution is in contact with all internal surfaces of the system. The cleaning solution should be circulated using the system recirculating pumps or temporary pumps depending on the design characteristics and construction scheduling.

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- 5) Once the cleaning solution has been circulated for the desired time the system should be drained and flushed using the automatic makeup water system for supply. The temporary strainers should be removed and replaced with permanent strainers.
- 6) The water should be analyzed with the following targets:

Test	Target
pH	Same as the makeup water
Specific Conductance	Same as the makeup water
Fe	< 1.0 ppm

- 7) Once the water quality is equal to the target limitations the system can be considered clean and ready to accept the initial charge of chemical inhibitors. Submit the form on the following page to FPM Facilities for review and approval. It is important that inhibitors and passivating agents are added to the system within 24 hours to prevent the corrosion and flash rusting. Untreated water shall not be allowed to remain in the system for more than 24 hours.
- 8) All water used for cleaning and flushing shall be drained to sewer.



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- b) Procedures, Open Systems:
    - 1) All cooling towers shall be isolated and all shutoff valves shall be arranged to bypass configuration in order to avoid chemical treatment entering the galvanized steel devices. Do not open the cooling tower to the cleaned piping until the system has been completely flushed with clean water.
    - 2) All other Closed System cleaning procedures shall be applied.
  - c) Procedures, Steam Boilers:
    - 1) Be sure the boiler is isolated at the steam header and that temporary site glasses have been installed. Add softened water to the boiler together with the proper amount of Trident 8002 pre-operational cleaner. The cleaning solution will be alkaline between 10.0- 11.0. The boiler should be fired to raise the temperature of the solution to 170 degrees and maintained for 24 hours. The boiler should be drained and flushed and refilled with clean softened water. The water should have < 1.0 ppm Fe and conductivity equal to that of the makeup water. The system should then be initially charged with chemicals to prevent corrosion.
    - 2) The steam system should be cleaned using steam to scour the piping surfaces using a condensing assembly to evacuate dirty condensate from the system. Condensate and steam should be bypassed around all appliances and steam traps. Dirty condensate should not be allowed to return to the feedwater system but rather discharged to drain. The system is considered clean when the condensate conductivity is < 100 and the Fe test is < 1.0 mg/ltr. Untreated water shall not be allowed to remain in the system for more than 24 hours.
2. Visual inspection of heat exchangers:
- a) HVAC contractor shall open condenser and evaporator heat exchangers (both ends) for inspection. Each exchanger shall be brushed and have eddy current testing performed prior to acceptance by owner.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 3113 METAL DUCTS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 73 23, 23 34 00, 23 36 00, 23 37 00, 23 38 13, 23 81 23, 23 81 26, 23 82 16, 23 82 19 and 23 84 13.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Air shall be ducted throughout the building, including within building chases, shafts, tunnels and mechanical rooms.
    - b) The use of ceiling return air plenums is allowed. No other non-metal plenums are allowed.
    - c) Ductwork shall be sized, selected and configured to limit the pressure drop to 1.5" or lower from fan discharge to exit of the diffuser in conditioned space, including all sound traps and other system losses.
    - d) Size ductwork based on the following maximum air velocity and air pressure drop requirements:

Location	Maximum Air Velocity	Air Pressure Drop	Comments
Duct main loops (high pressure)	Refer to 13 48 00 for acoustic velocity requirements	0.08" per 100'-0"	Air pressure drop to include fittings, transitions and the like. Maximum velocity shall be revisited in cases where no ceiling systems exist or distribution is exposed, or otherwise special acoustical considerations are required. Use whichever criteria provides the largest ductwork to comply with 1.5" overall system pressure drop.

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Location	Maximum Air Velocity	Air Pressure Drop	Comments
Secondary branch (low pressure)	Refer to 13 48 00 for acoustic velocity requirements	0.08" per 100'-0"	Air pressure drop to include fittings, transitions and the like. Use whichever criteria provides the largest ductwork to comply with 1.5" overall system pressure drop.
Transfer	Refer to 13 48 00 for acoustic velocity requirements	-	
Grease exhaust	Refer to 13 48 00 for acoustic velocity requirements	-	Size per current mechanical code
Laboratory exhaust	Refer to 13 48 00 for acoustic velocity requirements	-	Size per current mechanical code.

- e) If present, follow recommendations made by the acoustical engineer. In the event of a discrepancy with *USC Design Guidelines*, notify USC construction project manager to bring attention to FPM Engineering.
  - f) Oval duct is allowed for medium and low pressure ductwork and is only allowed for systems under positive pressure.
  - g) Minimize lining of fabricated metal air plenums and ductwork wherever possible.
2. Preferred:
    - a) Utilize a looped system when possible.
    - b) Use full ducted return system when possible.
  3. Disallowed:
    - a) Using Firewrap to establish a fire-rated enclosure is not allowed for grease duct or any other ductwork.

B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Metal Ducts:
  1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: No preferences
    - c) Disallowed: None
  2. Component Characteristics:

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a) Required:

1) Construct ductwork for the following pressure classes (minimum):

Pressure Class (" w.g.)	Location	Comments	Required Sealant class
1	<ol style="list-style-type: none"> <li>Supply ductwork downstream of terminal boxes.</li> <li>Low pressure supply and return ductwork at fan coil units that are direct driven.</li> </ol>	If anticipated operating pressure exceeds 1", use next pressure classification level.	B
2	<ol style="list-style-type: none"> <li>Return ductwork</li> <li>Exhaust ductwork</li> </ol>	If anticipated operating pressure exceeds 1", use next pressure classification level.	A
4	<ol style="list-style-type: none"> <li>Supply ductwork and plenum downstream of supply fan to terminal box</li> </ol>		A
6	<ol style="list-style-type: none"> <li>Where anticipated operating pressure exceeds all noted above.</li> </ol>		A

- Ductwork shall be selected and constructed on the more stringent of the current SMACNA standards or the current California Mechanical Code with local amendments.
- Construct specialty exhaust ductwork with the following materials:

Ductwork System	Material
Type I Hood Grease Exhaust	Type 304 Stainless Steel (18 gauge), Fully Welded
Type II Hood Dishwasher Exhaust (non-grease)	Type 304 Stainless Steel (18 gauge), Fully Welded
Laboratory Fume Exhaust	Type 316L Stainless Steel, Fully Welded and required in all shafts. Refer to Section 23 35 00 for additional requirements.  Note: Type 316L (not Type 316) is required due to welding specification.

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Ductwork System	Material
Wet/High Humidity Zones (i.e. showers)	Aluminum

- 4) Ducts shall have their ends kept sealed and be stored on pallets until the point at which the duct is installed in its final location. When the duct is installed in its final location, it shall have a temporary plastic seal put in place whenever active construction is not requiring access to the open end.
  - 5) Duct systems shall be cleaned just prior to startup using vacuum cleaning with mechanical agitation without disturbing the seal class or integrity of the ductwork systems. Contractor shall plan for this cleaning and ensure that adequate access panels in the ductwork are provided to accomplish the task.
  - 6) As part of best management practices during construction, where appropriate, temporary filtration shall be employed to limit debris entering duct systems, as part of overall measures towards assuring these systems remain clean prior to startup.
- b) Preferred:
- 1) For laboratory exhaust in ceilings, round longitudinally welded stainless steel ductwork is preferred with welds at 9 o'clock and 3 o'clock positions.
- c) Disallowed: None

#### 4. INSTALLATION REQUIREMENTS

- A. Required:
1. Install branch takeoffs with conical fittings or 45 degree entry taps.
  2. Provide manual balance dampers at each major branch takeoff and at run outs to diffusers and grilles of supply, return and exhaust ductwork. Refer to Section 23 33 00 for damper requirements.
  3. Provide access doors for grease exhaust ductwork per current mechanical code.
  4. Refer to Section 23 33 00 for flexible duct requirements.
  5. Provide necessary support for plenums as per SMACNA, which may be above standard ductwork support requirements.
  6. Install plenums so as to not impede access to adjacent equipment or portions of the ceilings/rooms in which they are installed.
  7. Provide access doors into all plenums and as noted in Section 23 31 13.
- B. Preferred:
1. Duct systems shall use radius elbows without turning vanes. Where this is not possible due to space constraints, provide miter elbows with turning vanes.



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C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required: Ductwork

B. Documentation required:  
1. Test reports: Duct Leakage Test

C. Required testing protocols:  
1. Duct Leakage:  
a) The following portions of systems are required to have leakage tests:

System	Location	Notes
Supply	In risers	With SFDs and access panels installed.
Supply	On floors, upstream of VAV boxes or zonal reheat coils	Blocked before VAV box, with access panels installed.
Return and Relief	Risers	With SFDs and access panels installed.
General Exhaust	Risers	With SFDs and access panels installed.
Pressurization-critical Exhausts	Entire system as a whole	With SFDs and access panels installed. Blocked at diffuser connections.

- b) Testing Protocol:
- 1) Seal all openings in duct section to be tested.
  - 2) Connect test apparatus to test section of duct, using a flexible duct connection or hose.
  - 3) Close damper or blower suction side to prevent excessive build up of pressure.
  - 4) Start blower and gradually open damper on suction side of blower.
  - 5) Build up pressure in duct test section equivalent to the duct construction gage. Negatively pressurized ducts shall be tested under negative pressure.
  - 6) Record indicated pressure or instrument that is connection to section of duct under test.
  - 7) Maintain this pressure for ten minutes and check for audible leaks. Mark location of each leak.
  - 8) Reduce pressure to 0 inch wg and repair all visual and audible leaks.
  - 9) Upon completion of repairs, build up pressure to the test pressure and read leakage pressure on instrument connected across test apparatus orifice. Repeat this procedure until the test complies with the required minimum leakage.
  - 10) Leakage CFM to be read by consulting chart calibrated with orifice diameter. If no leakage exists, zero pressure differential shall be

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indicated. Leakage CFM shall not exceed the value derived from the calculation methodology listed in the schedule on the previous page of this section.

- 11) Calculation methodology: follow SMACNA leakage testing calculation methodology, but apply leakage class below as associated with sealant classes as noted above: The maximum leakage allowed in cfm/sf is to be referenced against the seal class listed above and the definitions of seal class from Table 4-1 of the SMACNA HVAC Air Duct Leakage Test Manual.

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Seal Class	Leakage Class Allowed
A	6
B	12
C	24
Round Duct, all classes	3

- c) Engage the testing agency to verify the leakage tests of all ducts and submit a certification attesting to the results obtained.
- d) Tested sections of ductwork to be visually marked by agency with certification sticker and initials of field test inspector. Tests shall be made before duct sections are concealed.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 3300 AIR DUCT ACCESSORIES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section(s) 13 48 00, 23 31 13.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

- D. This section covers dampers, duct silencers, and flexible ducts.

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Manual balance dampers shall be provided at each major branch takeoff and at run outs to diffusers and grilles of supply, return, and exhaust ductwork. For acoustical considerations, see Section 13 48 00.
    - b) Select duct silencers from manufacturer's published acoustical and aerodynamic rating tables based on actual test readings or interpolated values of such readings obtained from tests made by recognized independent laboratories.
    - c) Silencer filler material shall meet appropriate fire hazard classification values, when tested in accordance with recognized standards/testing agencies following ASTM E477, ASTM E84, and NFPA 255 Standards.
    - d) Select and provide silencers for air pressure drops not exceeding 0.5 inches.
    - e) Flexible duct is allowed only at connections to supply diffusers and grilles.
    - f) Maximum length of flexible duct shall be limited to 6 feet.
    - g) Assure all proposed fire-smoke dampers retain the appropriate jurisdictional (local and state) approvals and listings.
    - h) Outside Air/Exhaust Air/ Relief Air louvers at exterior walls will be provided with minimum 1/2" wire mesh screen behind the louver.
  - 2. Preferred:
    - a) Provide sound attenuator or lining directly downstream of air handling unit discharge to prevent fan noise breakout from entering occupied spaces.
    - b) It is USC's strong preference that building full area coverage smoke detection be used to trigger air handling unit shut down and the shutdown of fire smoke dampers. This is allowed through exception by the mechanical and building codes.
  - 3. Disallowed: None

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- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Fire Smoke Dampers shall have a BIM family provided within the BIM model, inclusive of actuator motor information.

### 3. PRODUCT REQUIREMENTS

- A. Volume Damper:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: No preferences
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Including built in indication and locking mechanisms
    - b) Preferred: No preferences
    - c) Disallowed:
      - 1) Avoid using ceiling diffusers/registers with opposed blade dampers (OBD).
- B. Fire-Smoke Damper:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Ruskin
      - 2) Pottorff
      - 3) Approved equal
    - c) Disallowed: Less than 5 years warranty manufacturers.
  - 2. Component Characteristics:
    - a) Required:
      - 1) Where a duct smoke detector is installed for local damper control, a remote alarm indicator shall be provided at a visible location and as required by local jurisdictions code.
      - 2) When a damper is controlled by the fire alarm system, reference section 28 3100.
      - 3) Smoke detector shall be compatible with building fire alarm (FA) system, where FA exist, and can accommodate new devices. (Addressable type)
      - 4) Fire-Smoke dampers serving duct branches which handle  $\geq 2000$  CFM shall be provided with damper position feedback to the Honeywell BMS system.
      - 5) Minimum 5-year manufacturer warranty.
    - b) Preferred:
      - 1) External duct smoke detectors are preferred over in duct smoke detectors.
      - 2) Design shall ensure that minimum airflow requirements are met.
      - 3) Where a fire alarm system exists and dampers are not acting as part of smoke control system, provide a single supplementary fire alarm

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control relay to allow for BMS to separately monitor damper closure has occurred.

- 4) Fire/Smoke Dampers are to have limit switches to identify position and status shall be shown on the campus Honeywell system.
3. Combination fire-smoke dampers:  
Monitoring through BMS shall be provided for combination fire-smoke dampers (CFSD) serving ducts that handle 2,000 CFM and above.  
An interface modules (by control contractor) shall be connected to the double throw micro switches contact to provide full open and full closed damper blade indication to the Honeywell BMS.
- C. Duct Silencer:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Industrial Acoustics Company
      - 2) Vibro-Acoustics
      - 3) Approved equal
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Provide factory fabricated duct silencers of tubular or rectangular type as appropriate to meet project's Noise Criteria. Refer to Section 13 48 00.
      - 2) Construct silencers of galvanized steel with casing seams sealed or welded to be airtight at a pressure differential of 8 " w.g. between inside and outside of unit, stiffened and braced as required to prevent structural failure or deformation at same condition and to prevent audible vibration during normal operation. Where duct system is constructed of stainless steel, construct silencer of stainless steel.
      - 3) Provide silencers with an inert acoustical absorbing filler material consisting of inorganic mineral fiber or fibrous glass that is vermin, moisture-proof, and will impart no odor into air stream.
    - b) Preferred: No preferences
    - c) Disallowed: None
- D. Flexible Duct:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: No preferences
    - c) Disallowed:
      - 1) Alumaflex
  2. Component Characteristics:
    - a) Required:
      - 1) Provide flexible duct with inner rigid support system.
    - b) Preferred: No preferences
    - c) Disallowed: None

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- E. Grease Duct Access Door:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) DuctMate
      - 2) FlameGard
      - 3) 3M
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Airtight and suitable for duct pressure class.
      - 2) UL labeled meeting NFPA 96 standards.
      - 3) 304 stainless steel double-wall sandwich type construction. Lap inner face of door over duct opening, a minimum of 1/4-inch (6mm) on all four edges of the free duct opening.
      - 4) Provide chain to prevent inner piece from fall into duct.
      - 5) Grease-tight, high-temperature ceramic fiber gasket, rated for minimum 2300 deg.
      - 6) Provide compression type tightening latches.
    - b) Preferred: No preferences
    - c) Disallowed: None
- F. Hinged Rectangular Duct Access Door:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Greenheck
      - 2) Pottorff
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Airtight and suitable for duct pressure class.
      - 2) Minimum 26 gauge steel double-wall construction with 1 inch fiberglass insulation and beveled lock edge. Lap inner face of door over duct opening, a minimum of 1/4-inch (6mm) on all four edges of the free duct opening.
      - 3) Continuous piano type hinge.
      - 4) Frame duct opening with continuous 1 inch x 1 inch sheet metal angle.
      - 5) All parts to be Galvanized steel for galvanized ductwork.
      - 6) All parts to be 304 stainless steel for stainless steel ductwork.
      - 7) Foam gasket at door-to-frame and frame-to-duct.
      - 8) Door latches: operable rustproof zinc/aluminum alloy latch accessible from inside and outside duct. Steel and sponge rubber washers to prevent leakage. Beveled flange to work against frame to achieve compression.
      - 9) Sash locks: Up to 18" (25mm) square: Furnish two locks. Above 18" (25mm) square: Furnish three locks.
    - b) Preferred: No preferences
    - c) Disallowed: None

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### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. Install balancing dampers as far back from diffusers and grilles as possible to reduce damper generated noise. This includes conditions where low pressure distribution ductwork to accompanying diffuser and grilles is completely rigid.
2. Locate volume dampers on rigid portion of low pressure ductwork distribution and provide with locking mechanisms.
3. Locate volume dampers to be readily accessible to TAB contractors and operation and maintenance personnel.
4. Contractor shall properly tag all volume dampers concealed within plenum space or other architectural system in which these items are concealed. Refer to Section 23 0553 for identification of HVAC equipment.
5. Provide airtight construction for final installed placement of duct silencer by applying a duct sealing compound at all seams.
6. Install and support the flexible ducting in a way so as to not compromise the free open area.
7. Provide the appropriate radius and/or plenum accessories for proper top or side connections to air outlets or inlets to avoid pinching the flexible duct.
8. Provide access doors as noted below:

Equipment Requiring Access Doors	Location		Preferred Access Door Size (inches)	Remarks
	Upstream	Downstream		
Control Devices Requiring Inspection	Either		18x18	
Backdraft Damper	x	-	18x18	Ensure visibility of damper.
Fire Dampers	Either		8x8	Ensure visibility of damper.
Combination Fire & Smoke Dampers	Either		18x18	Ensure visibility of damper.
Duct Mounted Heating/Cooling Coil	x	-	18x18	
Humidifiers	x	x	12x12	Confirm access requirements with manufacturer
Duct Mounted Drain Pans & Seals	-	x	18x18	
Outdoor Intakes & Mixed Air Plenums	Either		18x18	One location per plenum.
Full Height Plenum	Either		24W x 60H	One location per plenum.
Grease Exhaust Ductwork	Refer to Section 23 3813			
Notes:				
<ul style="list-style-type: none"> <li>• Ductwork access doors shall be square/rectangular and be a minimum 4" smaller than ductwork size to allow for proper installation.</li> <li>• For ductwork/equipment located within T-Bar ceilings, no ceiling access panels are</li> </ul>				



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required. Refer to Section 23 0553 for colored dot requirement at ceiling panel.

- For ductwork/equipment located within hard lid enclosures, provide 18x18 ceiling access door. Access doors for fire dampers and combination fire and smoke dampers shall not require the use of tools, keys, or special knowledge.

B. Preferred:

1. It is preferred that on duct detectors shall be used in conjunction with Smoke Fire Dampers.

C. Disallowed:

1. Volume dampers may not be placed on flexible ductwork.

### 5. EVALUATION or COMMISSIONING

A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Fire-Smoke Dampers

B. Documentation required:

1. Test reports: Fire-Smoke Damper testing report, Testing, Adjusting, and Balancing report
2. UL listing: Fire-Smoke Dampers
3. Factory test results: Duct silencer acoustical and aerodynamic performance values.

C. Required testing protocols beyond normal Commissioning and TAB protocols:

1. Fire Alarm/Fire Damper Testing
2. Review of duct silencer submittals and application by project acoustical engineer (where one exists)

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 3400 HVAC FANS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 31 13, 23 33 00 and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

- D. Additional Information:
  - 1. Where centrifugal fans are an integral part of a piece of equipment specified elsewhere, that specification shall govern for fan performance.
  - 2. Where chemicals or flammable materials are anticipated, please see Section 23 35 00 for Special Exhaust Systems.

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Maximum speed for fans shall be 1750 RPM.
  - 2. Preferred: No preferences
  - 3. Disallowed:
    - a) Fan Motors shall not be selected in the service factor.
    - b) VFD shall not be selected to operate above 60Hz.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Fans shall have a BIM family provided within the BIM model, inclusive of motor information.

### 3. PRODUCT REQUIREMENTS

- A. HVAC fans and powered ventilators:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:

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- 1) Loren Cook
- 2) Greenheck
- 3) Penn
- 4) Twin City
- c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) For all fans and powered ventilators, provide accessories appropriate to type of fan to ensure workers safety, maintenance access and positive drainage in outdoor configurations (i.e. inlet/outlet screens, access doors and scroll drains among others)
    - 2) For powered ventilators and fans located in a location where building-borne vibration would adversely affect research equipment, occupant comfort, or sound performance required for the space, provide vibration isolation. Refer to Section 13 48 00 for vibration isolation requirements.
    - 3) All exhaust fans and powered ventilators on the roof of buildings require vibration isolation.
    - 4) For rooftop exhaust fans, provide factory mounted backdraft dampers, hinged access doors, disconnect switches and roof curbs (if required).
    - 5) Provide fans with direct drives and speed controllers, when available from the manufacturer.
  - b) Preferred: No preferences
  - c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  1. Provide hinged access panels to all motors, fans and filters, if available from the manufacturer.
  2. Install exhaust fans so that recommended clearances are maintained for access to motor, belts and drains.
  3. Where general exhaust fans are located on the roof in mechanical wells, provide utility type fans with discharge extensions to extend at least to the height of the penthouse or parapet.
- B. Preferred: No preferences
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: All fans.
- B. Documentation required:
  1. Testing, Adjusting and Balancing Reports.
  2. Commissioning report.
  3. UL listing.

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- C. Required testing protocols beyond normal Commissioning and TAB protocols: None.

**END OF DOCUMENT**

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## 23 3500 SPECIALTY EXHAUST SYSTEMS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 3113, 23 3300, 23 3400 and Division 11- laboratory equipment.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

- D. Additional Notes:
  - 1. This section is written specifically to cover Laboratory Exhaust and the corresponding ventilation control systems meant to achieve adequate pressurization control for typical wet and dry research and teaching laboratories on the USC Campus.
  - 2. Where any specialty requirements such as radioisotope hoods, perchloric acid hoods, BSL-3 suites, or cleanrooms are required by the Project's program, special attention must be paid to the design of these systems, and all systems, design intent, sizing criteria, control sequence of operations, and modes of emergency response must be presented in person, with substantiating calculations, to the USC project manager, FPM Engineering, and EH&S prior to 100% Design Development.
- E. USC will engage the campus wind consultant at Schematic Design in order to verify that the designer's proposed intake and discharge locations are placed appropriately to avoid adverse effects on neighboring buildings. Refer to Section 1 and Section 23 0000 for when a wind study is applicable.

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - 1) The designer is required to identify all intakes and discharge locations from equipment or louvers by 100% Schematic Design in order for the wind consultant to be engaged. The information required is as follows:
      - 1) Maximum and minimum air flows
      - 2) Air velocities and discharge vectors under maximum flow and minimum flow.

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- 3) Anticipated chemicals and concentration levels within the exhaust effluent under maximum and minimum airflows.
- 2) The design shall provide for a minimum of 10 air-changes per hour if the room is occupied and a minimum of 6 air-changes per hour if the room is unoccupied. Flows higher than these minimum values shall be justified on the basis of measured and extrapolated heat load data obtained in conjunction with the USC staff and user groups at similar facilities.
- 3) The designer shall determine if there is a need for off-hour operation of hood exhaust system, and design the system accordingly to allow for ramp down of systems during unoccupied modes.
- 4) If the program requires that fume hoods run continuously for the purposes of occupant protection, the design shall include the ability to provide both fume hood exhaust and associated makeup air quantities during normal and equipment failure maintenance activities.
- 5) Prior to 100% Schematic Design, the design team shall propose to the USC project manager their rationale for accommodating future change within the building and what their approach is to providing sufficient flexibility to accommodate changes in the sciences. The team shall propose what they believe to be a reasonable amount of spare capacity for upsizing the initially-installed exhaust and make-up air systems (if necessary). Additionally, the design team shall explicitly identify in plan the location where additional fume hoods could be located in the future and demonstrate how services have been sized to accommodate this growth.
- 6) Follow hood manufacturer recommendations for exhaust fan sizing and system design.
- 7) Locate exhaust fan discharge openings with respect to fresh air intakes to avoid re-circulation.
- 8) Prior to 100% Design Development, designer shall discuss with USC project manager and relevant Fire Authorities the design intent with regard to emergency operations of fans serving fume hoods.
- 9) Prior to 100% Design Development, designer shall submit to USC a comprehensive schedule of all systems handling chemical or flammable exhaust and identify appropriate materials, internal and external coatings, fan types, fan motor locations, fan motor types (explosion-proof or not), control methodology, and emergency power characteristics.
- 10) Coordination of exhaust stacks and rooftop parapets shall be coordinated during Schematic Design so that all obstructions can be incorporated into the wind study model.
- 11) Air valve downstream pressures shall be calculated to prove that the pressure control capacity of the valve is adequate for the system requirements.
- 12) Lab Controls Gateway shall have capability to interface with EMS via BacNet, Modbus, or LonTalk.
- 13) New (or existing exhaust) fans to be reused shall be selected (or validated) to maintain the necessary static pressure (and pressure drop across), required for operation of all existing or proposed air valves in the exhaust distribution system.
- 14) Engineer shall attain confirmation from FPM Facilities as to whether under the project circumstances, air valves are to be remotely monitored and integrated into local BMS or campus EMS.

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- 15) All existing fume hood exhaust fan systems, proposed to be reused to service new fume hoods, shall have independent TAB contractor provide assessment on current operating parameters and mechanical condition. Any necessary adjustments and service required for fan system to properly serve new requirements shall be accounted for by project imposing them.
  - 16) Constant volume fan systems intended for fume hood exhaust, shall not be combined with other types of exhaust distribution (including multiple fume hoods), unless air valves are provided at each exhaust source branch.
  - 17) Overall strategy and subsequent sequence of operation of specialty lab exhaust fans/systems, during a local or building fire event, shall be submitted for review.
  - 18) The mechanical engineer of record shall coordinate compatibility of fume hood exhaust air valve body material with conveyed fumes.
2. Preferred:
    - 1) Exhaust system may consist of an individual fan for each hood, however manifold systems shall be considered when installing multiple hoods.
    - 2) Exhaust fans shall remove a fixed air quantity from each hood unless lab design requires a variable volume application.
    - 3) Even in circumstances where allowed by code, manual volume dampers within fume hood related exhaust distribution shall be avoided. Though active control or monitoring may not be required, or strategy is constant volume, air valves shall be provided for proper balancing of multiple fume hoods, where they are common to a single exhaust fan system.
    - 4) Fume hood exhaust fan systems which have been in service for greater than 15 years, shall be replaced with new, when imposing new requirements upon them.
  3. Disallowed:
    - 1) The reuse of fume hood exhaust fan systems, to serve new requirements, which have been in service for greater than 20 years.
    - 2) Fan Motors shall not be selected in the service factor.
    - 3) Variable frequency drives shall not be selected to operate above 60Hz.
    - 4) Use of polymer (i.e., FRP, Polypropylene...etc.) exhaust ductwork for fume hood service.
    - 5) Use of spiral stainless steel exhaust ductwork for fume hood service.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Fans and air valves shall have a BIM family provided within the BIM model, inclusive of motor and valve-controller information.

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### 3. PRODUCT REQUIREMENTS

- A. Fume hoods: See Division 11 53 13.
- B. Specialty Laboratory Exhaust Fans.
  - 1. Manufacturers:
    - 1) Required: No requirements
    - 2) Preferred:
      - 1) Greenheck Vector line
      - 2) Strobic Air
      - 3) MK Plastics (only as necessary for intended chemical content)
      - 4) Skyplume Technologies (only as necessary for intended chemical content)
    - 3) Disallowed: Fans that do not have an approved OSP# for use on OSHPD projects.
  - 2. Component Characteristics:
    - 1) Required:
      - 1) Motor of exhaust fan shall be explosion proof and shall be kept out of the airstream.
      - 2) Mani-folded exhaust systems shall include automated fan isolation dampers to allow for lead/lagging of redundant fans or service to individual fans.
    - 2) Preferred: No preferences
    - 3) Disallowed: None
- C. Air Valves
  - 1. Manufacturers:
    - 1) Required: No requirements
    - 2) Preferred:
      - 1) Phoenix
      - 2) Accutrol "AccuValve"
  - 2. Component Characteristics:
    - 1) Required:
      - 1) Pressure independent air-valve assembly with the ability to respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a mani-folded system.
      - 2) The device shall have been proven to be pressure independent over a minimum of 0.6" to 3.0" W.C. drop across the valve, but shall be verified against the downstream pressure drop demands of the branch.
      - 3) All exhaust air valves shall be made of a material proven to be corrosion resistance to the chemicals and concentrations anticipated in the exhaust airstream, as determined by the engineer of record.
      - 4) Valve attachment to ductwork shall be via draw band or flanged connection. Coordinate with manufacturer on available connection type. Sheet metal screw attachment method is not permitted.
      - 5) The assembly's shaft, pivot arm, shaft support brackets, and internal mounting hardware: Type 316 stainless steel.



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- 6) The air valves in combination with their control devices shall demonstrate an airflow accuracy of  $\pm 5\%$  of reading (not full scale) at eight different airflows per valve.
  - 7) Additionally, the air valves shall demonstrate  $\pm 0.15\%$  of span over an airflow turndown range of no less than 8 to 1, including the combined effects of non-linearity, hysteresis, repeatability, drift over a one year period, and temperature effect.
  - 8) Factory calibrate each airflow control valve to job specific airflows. Use NIST traceable air stations and instrumentation having a combined accuracy of at least  $\pm 1\%$  of signal over the entire range of measurement.
  - 9) All electronic controls systems shall be open protocol with BacNet or Modbus gateway interface provided free of charge to USC for monitoring or set-point override by the campus building management system.
  - 10) All air valves shall be provided with provisions for field measuring or remote monitoring of pressure drop across individual valves.
- 2) Preferred:
- 1) Supply and return air valve bodies may be made of composite Teflon/Teflon-infused aluminum, if deemed compatible by the mechanical engineer of record.

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. All exhaust ductwork within shafts shall be Type 316L Stainless Steel, fully welded.
2. Exhaust ducts for fume hoods and fans shall be of non-corrosive construction.
3. Exhaust ducts for fume hoods shall be suitable for fumes to be conveyed. Provide special coatings on stainless ductwork, if required to achieve compatibility.
4. Provide fire rated enclosure or fire wrap around fume duct as required by applicable codes.
5. All airflow valves shall be individually marked with valve specific, factory calibration data. As a minimum, it should include: valve tag number, serial number, model number, eight point valve characterization information (electronic valves), and quality control inspection numbers. Hard copy printout to be included with as-built documentation.
6. Where exhaust fans are located on the roof in mechanical wells, provide utility type fans with discharge extensions to extend at least to the height of the penthouse or parapet. The requirements for stack discharge and dilution of effluent shall take precedence over this minimum extension requirement.

#### B. Preferred:

1. Coordination of exhaust stacks and rooftop parapets shall be coordinated during Schematic Design so that all obstructions can be incorporated into the wind study model.

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- C. Disallowed:
  - 1) Use of polymer exhaust duct systems
  - 2) Use of spiral stainless steel exhaust duct systems.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Air-valves. Exhaust fan operation in conjunction with Fume Hood testing per University EH&S/OSHA requirements described in Division 11. Lab air valve systems and special exhaust systems require start-up by a factory representative or factory certified representative.
  - 1. Testing, Adjusting and Balancing reports.
  - 2. On-Site testing: Exhaust fan operation during Fume Hood EH&S acceptance testing (see Division 11)
  - 3. UL listing: Fume Hoods, Exhaust fan motors.
  - 4. Calibration curves for air valves.
  - 5. Factory Technician Start-up report
  - 6. Field certification of hoods and calibration of factory furnished sensors, in accordance with appropriate testing standard and specific manufacturer procedures for each respective hood type (see Division 11).
    - 1) Results shall turned over to owner to document the as installed condition
- B. Required testing protocols beyond normal Commissioning and TAB protocols:
  - 1. See EH&S Fume Hood acceptance protocols as noted in Division 11.

**END OF DOCUMENT**

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## 23 3600 AIR TERMINAL UNITS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 13 48 00, 23 31 13, 23 33 00, 23 82 16, and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Size terminal units for required maximum flow to be no more than 80% of peak rated flow for the box for the necessary sound level. Size terminal units to ensure that required minimum flow (to meet energy code requirements) is above the manufacturer's recommended minimum flow for the chosen box type, controller type, and velocity sensor.
    - b) Minimum CAV/VAV box: Size 6
    - c) Maximum CAV/VAV box: Size 14
    - d) Maximum discharge temperature of supply air in heating mode shall be 90-95°F.
    - e) Provide minimum 2-row reheat coils for all exterior and interior zones. Refer to Section 23 82 16 for reheat coil requirements.
    - f) For exterior zones, thermostats associated with air terminal units shall not be located on exterior walls or walls where direct sunlight is present for extended amount of time. Locate thermostats on interior walls or on columns.
    - g) Engineer to coordinate with project team to determine if there are project specific acoustical performance requirements. In the absence of such project specific requirements, refer to criteria set forth in Section 13 4800 Acoustics and Vibration Requirements to determine air terminal unit configuration.
    - h) Refer to Section 23 0000 for requirements on zoning strategies for Terminal Units (CAV/VAV boxes).
    - i) Refer to Section 23 0000 for limitations on relocation of Terminal Units (CAV/VAV boxes) in new renovation projects.

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- j) Where medium pressure ductwork from nearby main to inlet of terminal unit is greater than 10 feet in length, as designed, this ductwork shall be sized up to the next even size diameter (or equivalent rectangular dimension).
- k) Heating hot water branch piping should connect to the top of hot water mains.
- 2. Preferred: No preferences
- 3. Disallowed:
  - a) Do not size new air terminal units to maximum CFM capacity for units.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Terminal units shall have a BIM family provided within the BIM model, inclusive of actuator motor information.

### 3. PRODUCT REQUIREMENTS

- A. Constant-Air Volume Unit:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Price
      - 2) Titus
      - 3) Krueger
  - 2. Component Characteristics:
    - a) Required:
      - 1) Terminal unit shall be constructed of minimum 22 gage galvanized steel.
      - 2) Provide terminal unit with fiber-free insulation. For projects with specific acoustical performance requirements, specify factory extended attenuator unit with fiber-free insulation.
      - 3) For distribution to multiple ductwork branches, provide factory multi-outlet plenum on discharge of the terminal unit with fiber-free insulation; specify outlet quantities.
      - 4) Provide factory access door with means of easy removal and replacement, including an acceptable form of latching which does not require tools to open and close.
      - 5) Provide factory fabricated access doors designed / constructed to be airtight, including gaskets (or other acceptable solution) that allows for proper sealing when panels are removed and reset during normal service. Access doors larger than 12 x 12 shall be hinged.
      - 6) DDC controller and damper motor shall be mounted at the factory. Field mounted units are not permitted.
    - b) Preferred:
      - 1) It is preferred that the access door is hinged, no matter of the size.
    - c) Disallowed:
      - 1) Sound attenuating plenum shall not be field fabricated.
      - 2) Access door shall not be field fabricated.
      - 3) Cellular/cellulose insulation is not allowed.

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### B. Variable-Air Volume Unit:

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Price
    - 2) Titus
    - 3) Krueger
2. Component Characteristics:
  - a) Required:
    - 1) Provide terminal unit with fiber-free insulation. For projects with specific acoustical performance requirements, specify factory extended attenuator unit with fiber-free insulation.
    - 2) For distribution to multiple ductwork branches, provide factory multi-outlet plenum on discharge of the terminal unit with fiber-free insulation; specify outlet quantities.
    - 3) Provide factory access door with means of easy removal and replacement, including an acceptable form of latching which does not require tools to open and close.
    - 4) Provide factory fabricated access doors designed / constructed to be airtight, including gaskets (or other acceptable solution) that allows for proper sealing when panels are removed and reset during normal service. Access doors larger than 12 x 12 shall be hinged.
    - 5) DDC controller and damper motor shall be mounted at the factory. Field mounted units are not permitted.
  - b) Preferred:
    - 1) It is preferred that the access door is hinged, no matter of the size.
  - c) Disallowed:
    - 1) Sound attenuating plenum shall not be field fabricated.
    - 2) Access door shall not be field fabricated.
    - 3) Cellular/cellulose insulation is not allowed.

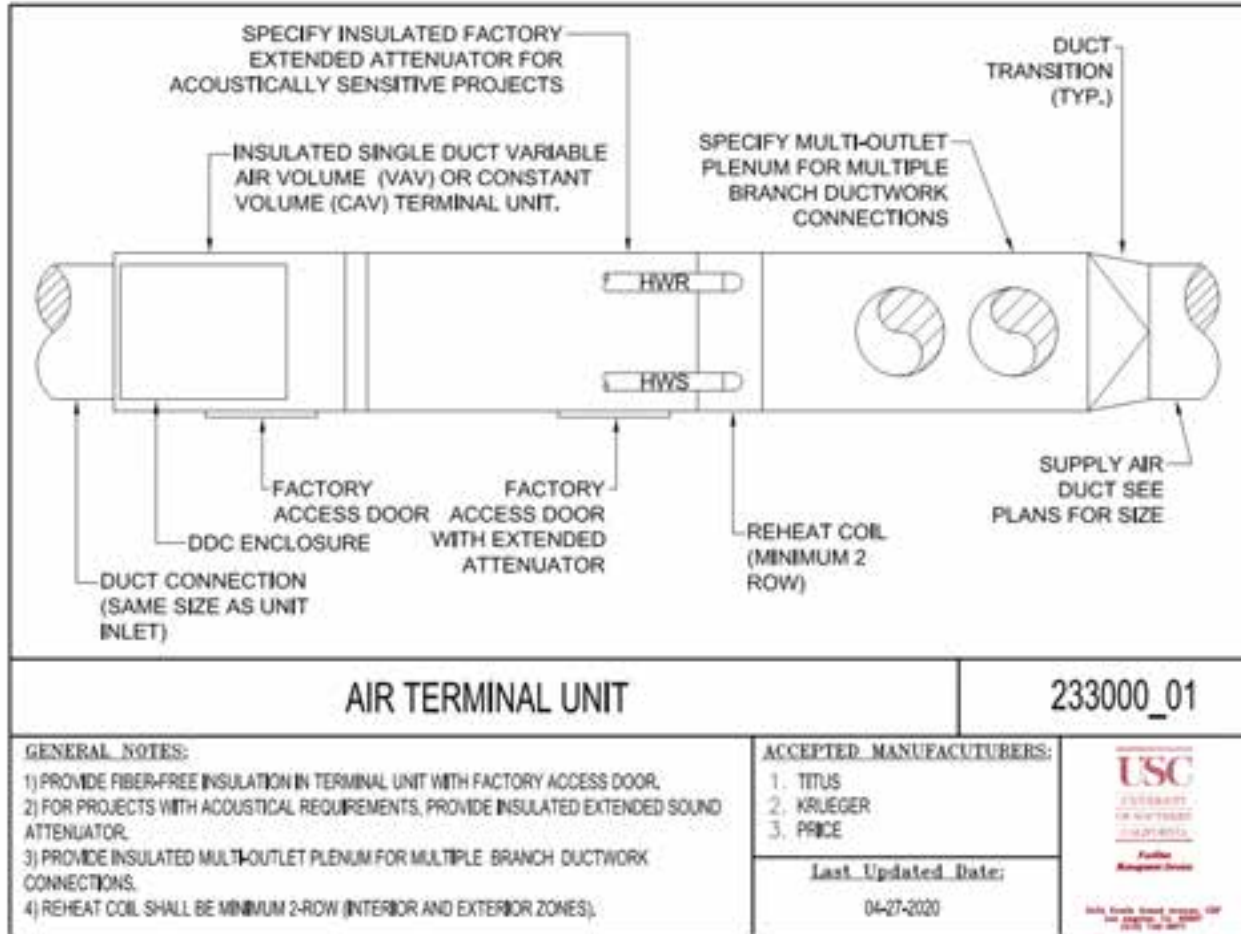
## 4. INSTALLATION REQUIREMENTS

### A. Required:

1. Provide duct access panels adequately sized for inspection and cleaning of coil in ductwork upstream and downstream of coil. Where necessary, detail or specify multiple access panels for larger size reheat coils.
2. Where medium pressure ductwork from nearby main to inlet of terminal unit is greater than 10 feet in length, due to final trade coordination demands, this shall be brought to attention of design engineer for confirmation of appropriate re-sizing ductwork to terminal unit.
3. Where field fabricated, provide access doors designed / constructed to be air tight, including the necessary gaskets (or other acceptable solution) that allows for proper sealing when panels are removed and reset during normal service.

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4. Provide sample of proposed access door solution and a mock-up of a single terminal unit with access door installed for FPM Facilities to review if acceptable.
5. Permanent hanging supports shall not be attached to terminal unit at locations that hinder removal of items requiring regular access, such as coil access panels.
6. Where greater than ten (10) terminal units are to be replaced or installed new, provide full scale mock-up of proposed re-heat piping coil connection strategy, including all related accessories (valves, strainers, etc.).
7. Heating hot water branch piping should connect to the top of hot water mains.
8. Refer to and follow the detail below for air terminal unit installation:



- B. Preferred:
1. Install air terminal units in accessible areas (ceiling grid). If terminal unit needs to be located over hard gypsum ceiling, provide a minimum 24" x 24" access panel. Coordinate location of access panel with architect.
  2. Minimum service clearance of 24" shall be maintained for terminal unit control enclosure, as well as piping accessories at coil connections separately.
  3. Provide full scale mock-up of proposed re-heat piping connection strategy.
- C. Disallowed: None

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### **5. EVALUATION or COMMISSIONING**

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Terminal Units (CAV/VAV boxes).
- B. Documentation required:
  - 1. Test reports: Testing, Adjusting and Balancing Report
  - 2. Commissioning
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**

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## 23 3700 AIR OUTLETS AND INLETS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Sections 23 31 13 and 23 33 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required: Nonmetallic (polymer) diffusers and exhaust grilles in acid preparation rooms.
  - 2. Preferred:
    - a) Provide painted galvanized steel diffusers for most normal applications.
    - b) Provide stainless steel or aluminum steel in wetted environments.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required

### 3. PRODUCT REQUIREMENTS

- A. Diffusers, registers, and grilles:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Price
      - 2) Titus
      - 3) Krueger
      - 4) Tuttle & Bailey
      - 5) Approved equal.
    - c) Disallowed: VAV thermal diffusers.
  - 2. Component Characteristics:
    - a) Required: No requirements
    - b) Preferred: No preferences
    - c) Disallowed:
      - 1) No opposed blade dampers allowed. Request to use such due to justified constraints shall be submitted to FPM Engineering for review.



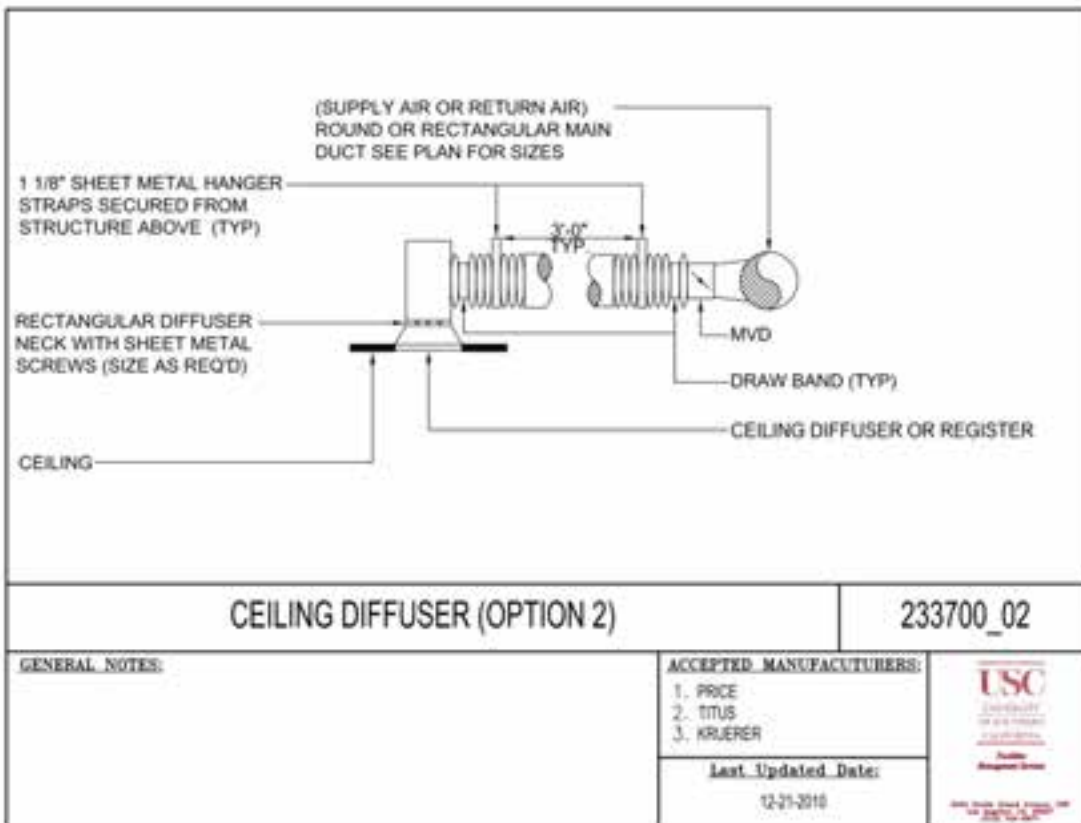
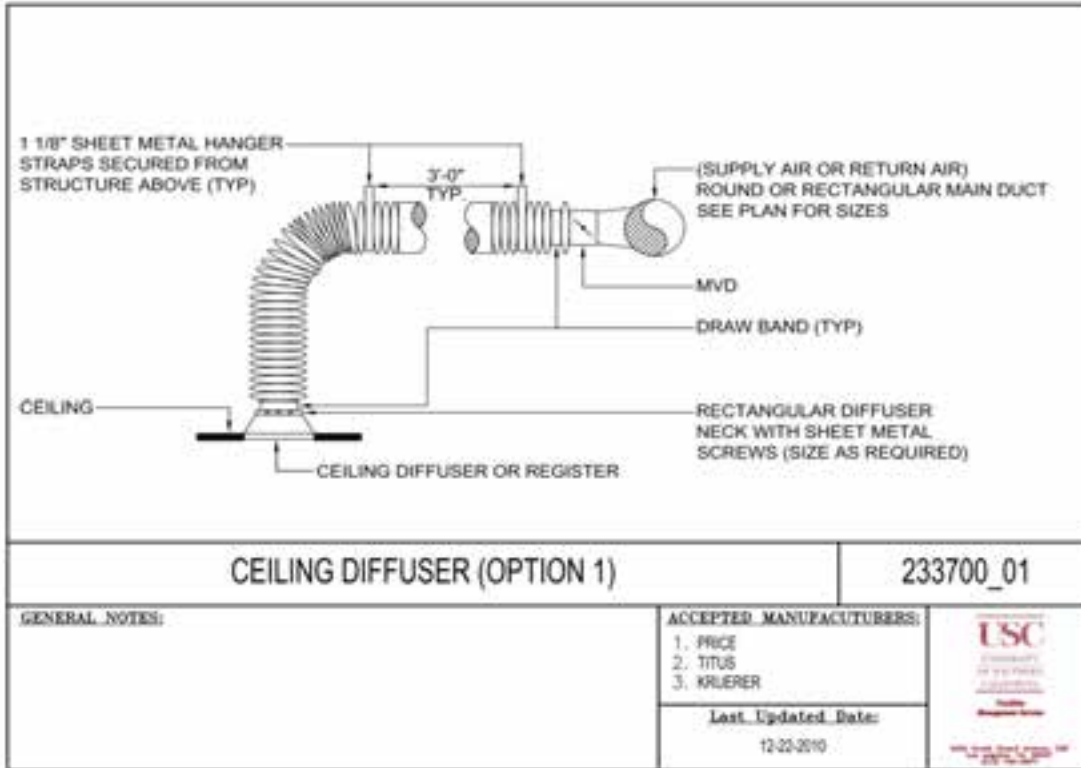
## USC DESIGN GUIDELINES

- 2) Diffusers with built-in thermostats and integral modulating dampers.
  - 3) Metallic air outlets and inlets within acid preparation rooms.
- B. HVAC Gravity Ventilators:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Loren Cook
      - 2) Greenheck
      - 3) Penn
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Unit shall be of bolted and welded construction utilizing corrosion resistant fasteners.
      - 2) Aluminum hood shall be constructed of minimum 14 gage marine alloy aluminum, bolted to a minimum 8 gage aluminum support structure.
      - 3) Aluminum base shall have continuously welded curb cap corners for maximum leak protection.
      - 4) Provide unit with ½” mesh bird screen mounted across intake/relief opening.
      - 5) Provide unit with anti-condensate coating.
      - 6) Provide gravity type back-draft or relief dampers at relief or exhaust ventilators. Gravity relief dampers shall fully open at 0.05-0.1” w.g. static pressure. Hood shall be low silhouette type.
      - 7) Provide all required accessories for proper operation of ventilators per code and in accordance with design intent and sequence of operation.
    - b) Preferred: No preferences

#### 4. INSTALLATION REQUIREMENTS

- A. Required:
1. Refer to the details on the following page for diffuser installation options:

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B. Preferred: No preferences

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Diffuser flow balancing. Outside air measurement.
- B. Documentation required:
  - 1. Test reports: Testing, Adjusting, and Balancing reports.
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 3813 COMMERCIAL-KITCHEN HOODS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 31 13 and 23 33 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Kitchen ventilation systems shall comply with current CMC requirements and all applicable amendments.
    - b) Kitchen ventilation system shall be capable of maintaining kitchen temperature above 68°F during heating mode and below 76°F during cooling mode.
    - c) If wash-down is provided at pollution control units, coordinate water source and necessary backflow prevention with Plumbing.
    - d) If wash-down is provided at commercial kitchen hood, coordinate water source and necessary backflow prevention with Plumbing.

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- e) Pressure drop calculations and duct/discharge velocity conditions shall be submitted to FPM Engineering prior to 100% Design Development and shall account for both clean and dirty filter conditions.
  - f) Where electrostatic precipitators not included in centralized pollution control unit, provisions for protecting charcoal filters shall be included.
  - g) VAV type systems will only be considered under the appropriate circumstances and on a case by case basis.
2. Preferred:
- a) Provide centralized pollution control units
  - b) Electrostatic precipitators are preferred over UV technology
  - c) If UV technology is utilized, provide automatic wash-down system at hood.
  - d) Considerations for odor control and measures for providing such shall be coordinated with the University.
  - e) Where basic start/stop kitchen hood control is required, this shall be provided adjacent to the hood for manual control by end user (as oppose to automatic control through the building automation system).
  - f) Monitoring of equipment status for dedicated kitchen hood fan systems, via the building automation systems (BAS) is acceptable for new installations, and where existing BAS infrastructure is available and readily expandable.
3. Disallowed:
- a) UV hoods and precipitators shall not be provided in combination.
  - b) Precipitators built into hood system or within exhaust duct are not allowed.

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- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Pollution Control Units and hoods shall have a BIM family provided within the BIM model, inclusive of motor, filter, and hood controller and fire protection information.

### 3. PRODUCT REQUIREMENTS

- A. Commercial-kitchen hoods:
  - 1. Manufacturers:
    - a) Required:
      - 1) Ultimate responsibility for the hood specification shall lie with the food services consultant
    - b) Preferred:
      - 1) Gaylord
      - 2) Halton
      - 3) Greenheck
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide U.L. listed stainless steel kitchen hood of the 100% exhaust type.
      - 2) Provide a state fire marshal approved fire protection system inside kitchen hood.
    - b) Preferred: No preferences
    - c) Disallowed:
      - 1) Short circuit hood where make up air is introduced directly into the hood.
      - 2) If precipitators are provided they shall be centralized at the pollution control unit not at the hoods.
- B. Pollution Control Units:
  - 1. Manufacturers:
    - a) Required:
      - 1) Ultimate responsibility for the hood specification shall lie with the food services consultant
    - b) Preferred:
      - 1) Gaylord
      - 2) Halton
      - 3) Greenheck
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide centralized electrostatic precipitator (as applicable) and charcoal/carbon filter.
      - 2) Provide automatic wash-down at the pollution control units.
    - b) Preferred: No preferences
    - c) Disallowed: None

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### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - a) Locate and install control switches for HVAC equipment so to prevent unauthorized use.
  - b) Layout of grease ductwork shall be coordinated such that there is the minimum required number of access door locations to meet the requirements of the Mechanical code and so they are placed in accessible locations not blocked by kitchen equipment or in food service areas. Highlight access doors in set of shop drawings for review by FPM Facilities.
  - c) Prior to construction, specific shop drawings for grease exhaust distribution, along with proposed pressure drops and confirmation of design air balance, shall be provided by contractor for FPM Engineer to review.
- B. Preferred:
  - 1. Fully enclose grease duct in gypsum board fire-rated enclosure.
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Kitchen hoods.
- B. Documentation required:
  - 1. Test reports: Testing, Adjusting, and Balancing reports. UL listing: Kitchen Hood.
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 4000 HVAC AIR CLEANING DEVICES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Sections 23 34 00, 23 73 23, 23 81 23, 23 81 26 and 23 82 19.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Within design documents, explicitly state anticipated pressure drop for velocity specified and MERV rating per ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
    - b) Comply with NFPA and Code requirements with necessary UL Class ratings.
    - c) Maximum velocity allowed across filter is 500fpm or required coil face velocity of the device, whichever is lower.
  - 2. Preferred:
    - a) USC stocks the following standard size filters and it is preferred that these sizes be specified (or latest University practice):
      - 1) For centralized equipment:  
12 x 24 inches and 12x24: MERV 15
      - 2) For air filters in decentralized equipment, stock sizes are:
 

12x24x2	20x30x2	20x20x4
16x20x2	24x24x2	20x24x4
16x24x2	25x25x2	20x25x4
16x25x2		24x24x4
18x24x2	12x24x4	
18x20x2	16x20x4	
20x20x2	16x25x4	
20x24x2	18x24x4	
20x25x2		



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3. New or replacement decentralized systems shall be equipped with minimum 2" thick MERV 13 filters, or current code required MERV rating, whichever is more stringent. No exception.
  4. Disallowed:
    - a) Metal "cleanable" type filters are not allowed.
    - b) 1" Thick filters on new systems.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. BIM information related to filters shall be included within the BIM object that contains the filters but shall include clean and dirty filter pressure drops and direction on frequency and procedures for replacement.

### 3. PRODUCT REQUIREMENTS

#### A. DISPOSABLE, EXTENDED AREA PANEL FILTERS

1. Manufacturers:
  - a) Required: No requirements.
  - b) Preferred:
    - 1) Flanders
    - 2) Camfil Farr Filtration Group.
    - 3) AAF International.
    - 4) Environmental Filter Corporation (EFC).
    - 5) Eco-Air.
    - 6) American Air Filter.
  - c) Disallowed: None.
2. Component Characteristics:
  - a) Required:
    - 1) UL 900 Class 2 media
    - 2) Cardboard frame.
    - 3) ASHRAE 52.1 performance: MERV 13, Dust spot efficiency 80%-90%, Initial resistance @ 500 fpm: 0.30 in W.G., Final resistance: 1.0 in W.G.
  - b) Preferred:
    - 1) A 4" filter is preferred for extended loading characteristics, however, where these are used for fan coil units or split systems, a 2" filter may be used.
  - c) Disallowed: 1" thick filters.

#### B. EXTENDED SURFACE HIGH EFFICIENCY MEDIA FILTERS

1. Manufacturers:
  - a) Required: No requirements.
  - b) Preferred:
    - 1) Flanders
    - 2) Camfil Farr Filtration Group.
    - 3) AAF International.
    - 4) Environmental Filter Corporation (EFC).
    - 5) Eco-Air.

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- 6) American Air Filter.
    - c) Disallowed: None.
  - 2. Component Characteristics:
    - a) Required:
      - 1) UL 900 Class 2 media, Mini-pleated, water-resistant glass fiber with separators; in rigid holding frame with corrosion resistant coating.
      - 2) ASHRAE 52.1 performance: MERV 14, Dust spot efficiency 95%, Initial resistance @ 500 fpm: 0.38 in W.G., Final resistance: 1.5 in W.G.
    - b) Preferred:
      - 1) A 12" filter is preferred for extended loading characteristics.
    - c) Disallowed: None.
- C. HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTERS
- 1. Manufacturers:
    - a) Required: No requirements.
    - b) Preferred:
      - 1) Flanders
      - 2) Camfil Farr Filtration Group.
      - 3) AAF International.
      - 4) Environmental Filter Corporation (EFC).
      - 5) Eco-Air.
      - 6) American Air Filter.
    - c) Disallowed: None.
  - 2. Component Characteristics:
    - a) Required:
      - 1) UL 586 media, pleated, water-resistant all-glass fiber paper with separators
      - 2) Filter shall be factory constructed to encapsulate the top and bottom of the filter pack and frame joints in a completely leak-tight manner.
      - 3) Filter Frames: Galvanized steel, aluminum, or stainless steel, assembled in a rigid manner. Face Gasket: Silicone.
      - 4) MIL-STD-282 Test 0.3 Micron Dioctyl Phthalate Smoke (DOP) Efficiency: 99.97 percent. Initial resistance @ 250 fpm: 0.65 in W.G., Final resistance: 3.0 in W.G.
    - b) Preferred:
      - 1) A 12" filter is preferred for extended loading characteristics.
    - c) Disallowed: None.
- D. ACTIVATED CARBON FILTERS
- 1. Manufacturers:
    - a) Required: No requirements.
    - b) Preferred:
      - 1) Flanders
      - 2) Camfil Farr Filtration Group.
    - c) Disallowed: None.
  - 2. Component Characteristics:
    - a) Required:
      - 1) Activated Carbon Density: 34 lb/cu ft , pellets or granular to 6 x 10 Tyler mesh screen. Carbon Tetrachloride Activity: Minimum 60

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percent; in thin bed. Carbon: 1.42 cu ft per 1000 cfm nominal airflow capacity.

- 2) Filter Frames: Galvanized steel unit incorporating extruded aluminum tracks to accommodate filter servicing trays in deep V arrangement arranged for servicing with disposable panel pre-filter.
  - 3) IES Designation: RP-8, efficiency of 99.9 percent. Initial resistance @ 500 fpm: 0.45 in W.G.
  - 4) All carbon filters shall be provided with a disposable panel “dusting” filter downstream of the carbon filter.
- b) Preferred:
- 1) Side servicing is preferred.
- c) Disallowed: None.

### E. FILTER FRAMES

#### 1. Manufacturers:

- a) Required: No requirements.
- b) Preferred:
  - 1) Flanders
  - 2) Camfil Farr Filtration Group.
  - 3) AAF International.
  - 4) Environmental Filter Corporation (EFC).
  - 5) Eco-Air.
  - 6) American Air Filter.
- c) Disallowed: 1” Filter Frames.

#### 2. Component Characteristics:

- a) Required:
  - 1) If incoming ductwork is stainless steel, use stainless steel, otherwise use 16 gage extruded aluminum T-section construction with necessary gaskets between frames and walls
  - 2) Permanent gasket framing members to prevent the bypass of unfiltered air. Each horizontal row of filters shall have a positive spring loaded sealing device which will allow easy installation and removal of cartridges but shall secure seal between cartridges while bank is in operation.
- b) Preferred:
  - 1) Provide a separate gasketed track for pre-filters, which can be serviced from upstream without disturbing the final filters.
- c) Disallowed: None.

### F. FILTER GAGES

#### 1. Manufacturers:

- a) Required: No requirements.
- b) Preferred:
  - 1) Dwyer Photohelic Series for BAS-linked gage.
- c) Disallowed: None.

#### 2. BAS-linked gage Component Characteristics:

- a) Required:
  - 1) Direct Reading Dial: 3-1/2 inch diameter diaphragm actuated dial in metal case. 2 percent of full scale accuracy.
  - 2) Furnish vent valves, black figures on white background, front calibration adjustment

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- 3) Range: 0-2.0 in W.G for 30-35% prefilters, 0-3.0 in W.G for final filters, 0-4.0 in W.G for HEPA filters
  - 4) Provide transmitter contacts for interface to building control system to be 4-20mA signal.
- b) Preferred:
- 1) Provide a separate gasketed track for pre-filters, which can be serviced from upstream without disturbing the final filters.
  - 2) Provide gauge with standard air filter installation kit.
- c) Disallowed: None.

### 4. INSTALLATION REQUIREMENTS

A. Required:

1. Furnish three sets of filters for every device: temporary construction filters; one to be used during the testing, adjusting and balancing period; and one to be used at handover. At the client's discretion, leave the TAB filters in place at handover and provide the other set in factory packaging to the client for extra stock.
2. Locate gages as near as possible to 5 feet above floor and in a level manner. Mount filter gages immediately outside of filter housing.
3. Install filter gages on filter banks with separate static pressure taps upstream and downstream of each filter bank - this means that if the pair of pre and final filters are mounted in the same rack, pressure measurement points must be provided for each.
4. Outdoor units shall have the gage enclosed in a protective sheet metal box with a hinged inspection door.
5. Install pre- and final filters with felt, rubber, or neoprene gaskets to prevent passage of unfiltered air around filters. Install HEPA filters with silicone gaskets.
6. Samples: Submit two samples of replacement filter media of each type and each filter frame.

B. Preferred: No preferences

C. Disallowed:

1. Do not operate fan system until temporary filters are in place. Replace temporary filters used during construction and testing, with clean permanent set prior to testing, adjusting and balancing.
2. The contractor may not run air-conditioning equipment until startup, testing, adjusting and balancing is ready to begin. Temporary filters shall be used at startup, with a MERV rating of 13 or higher and the filters required by this section as "permanent" filters shall be used for testing, adjusting and balancing.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required items: Filters
- B. Documentation required:
1. MERV rating documentation.
  2. UL Class documentation.

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3. Manufacturer's Installation Instructions: Submit assembly and change-out procedures.
- C. Required testing protocols: None

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 5100 BREECHINGS, CHIMNEYS AND STACKS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 52 33.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Prior to 100% Construction Documents, chimneys and stacks shall be braced for wind and seismic loads. Calculations stamped by a professional engineer for anchorage and drawings showing coordination of supports and braces to be provided for FPM Engineering review.
    - b) Material for inner liners shall be type AL 29-4C® stainless steel if condensation is anticipated.
    - c) Prior to 100% Design Development, where manifolded flue designs are proposed, engineer shall provide to USC pressure calculations to prove adequate performance to represent the breadth of likely permutations of staging scenarios.
  - 2. Preferred:
    - a) Boilers shall be placed to minimize length of chimney running within the building.
    - b) Use of UL listed equipment is preferred. Listing shall be appropriate to internal pressure anticipated.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS

- A. Breechings, chimneys and stacks:
  - 1. Manufacturers:
    - a) Required: No requirements.
    - b) Preferred:
      - 1) Selkirk.
      - 2) Metal fab.

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- 3) AMPCO.
2. Component Characteristics:
  - a) Required:
    - 1) All fittings and accessories to match rating of primary chimney assembly.
  - b) Preferred:
    - 1) Double wall construction with internal liner of stainless steel is preferred for flues extending through the building.
    - 2) When boilers are located on a roof and directly vented with short lengths to outdoors, double wall vents are not required and boiler manufacturer shall provide vents and vent terminations as accessories.
  - c) Disallowed:
    - 1) Single wall vents are not allowed for use within any type of internal or concealed construction. They may only be used for direct venting of rooftop boiler equipment.

#### 4. INSTALLATION REQUIREMENTS

- A. Required:
  1. Chimneys shall be installed level & plumb.
  2. Paint exterior components with a minimum of 2 coats of heat resistant paint.
- B. Preferred:
  1. Install slip joints to allow removal of appliance without disruption to breeching, chimneys or stacks.

#### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: None.
- B. Documentation required: None.
- C. Required testing protocols: None.

**END OF DOCUMENT**

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## 23 5233 WATER-TUBE BOILERS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13 and 23 21 16.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Hot water boilers shall be used on projects where steam requirements are minimal or this utility is not available.
    - b) Design engineer shall specify the efficiency and the method of calculation. System design measures shall be taken to avoid thermal shock and condensation of combustion gases in non-condensing boilers.
    - c) Air separators and expansion tanks shall be provided on all hot water heating systems regardless of piping arrangement.
    - d) Provide reverse return design to at header connection to boiler.
    - e) Boilers shall control primary pumps in a primary/secondary configuration. BMS system shall control secondary pumps.
    - f) Size boilers so that when one unit is out, the remaining unit(s) shall provide 70% of the anticipated block load.
    - g) Measures shall be accounted for to protect boilers from low return water temperatures (as applicable).
    - h) Water storage shall be provided (as necessary) to supplement the piping system, so to assure minimum recommended volume requirements.
    - i) Measures shall be accounted for to allow for a hot water supply temperature reset strategy.
    - j) Variable frequency drives for boilers shall be designed with NEMA 3R enclosures.
  - 2. Preferred: No preferences



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- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Boilers shall have BIM families provided within the BIM model, inclusive of fan, motor, manufacturer-provided pumps and controller information.

### 3. PRODUCT REQUIREMENTS

- A. Water-tube boiler:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Parker
      - 2) Cleaver-Brooks
      - 3) Lochinvar
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide Low Nox hot water boilers that meet minimum state and local efficiency and emission standards.
      - 2) Provide "low fire hold aquastat" to keep burner at low fire position until the water in the boiler reaches 212°F (to prevent thermal shock to tube sheets). Once water reaches 212°F, burner modulating control shall be released to normal function.
      - 3) Provide a microprocessor based boiler management control system with remote communications package and software package to interface with a 3<sup>rd</sup> party facility management system. Boiler management control system and remote communications package shall be capable of providing the 3<sup>rd</sup> party facility management system a 4-20 mA signal indicating the burner rate of (0-100%) updated once every 5 seconds (minimum).
      - 4) Where available, native boiler controller shall be specified to match the same manufacturer as the anticipated building management system standard, so to assure seamless connection and integration.
      - 5) When boilers are equipped with variable frequency drives, the enclosures shall be NEMA 3R rated.
    - b) Preferred: No preferences

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. The Contractor shall install the boiler with adequate clearances to allow removal of the boiler bundle, without the need to remove the entire boiler.
  - 2. Arrange gas and hot water piping to facilitate boiler bundle removal and future removal of the boiler.

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- B. Preferred: No preferences

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Boilers, manifolded flue configurations.
- B. Documentation required:
  - 1. Test reports: Testing, Adjusting, and Balancing reports. Commissioning report.
  - 2. Factory testing: Combustion efficiency report.
  - 3. On-site testing: Combustion efficiency report for boilers with manifolded flues.
  - 4. South Coast Air Quality Management certificate: Boilers.
  - 5. UL listing.
- C. Required testing protocols beyond normal Commissioning and TAB protocols:
  - 1. Provide onsite Combustion Efficiency testing of all boilers working under simultaneous use and using a common manifolded flue.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 5700 HEAT EXCHANGERS FOR HVAC

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13, 23 21 16, 23 22 13 and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) ASME stamp per Boiler and Pressure Vessel Code: Section VIII, Division 1.
    - b) Calculate required size of unit to produce the output shown after deducting for scale formation of tube surfaces using a fouling factor of 0.0005.
    - c) Temperature range for operation will be a maximum of 180°F. Applications that allow for a sliding temperature scale shall be 180°F at 32°F outside air temperature and 120°F at 65°F outside air. These systems shall also shut off at about 65°F outside air. The circulation pumps on these systems will run for a minimum of 10 minutes after the steam has been shut down to eliminate the possibility of the temperature of the exchanger exceeding the 180°F.
    - d) Steam relief valves shall be at 125 psi, at size of heat exchanger, with vents piped to the outside of the building above the roof line away from overhangs and air intakes.
    - e) Hot water relief shall be at 75 psi, at size of heat exchanger, and piped to a sanitary drain.
    - f) Provide reverse return piping design at header of heat exchanger.
    - g) When selecting heat exchanger, consideration shall be given to available steam supply pressure at specific building site or region of campus as well as estimated upstream pressure drop associated with piping accessories and control devices.
    - h) Any space housing steam generating or consuming systems, (Mechanical or Plumbing steam rooms) shall be properly ventilated and/or conditioned, in order to maintain room temperatures not to exceed 85°F.
  - 2. Preferred:
    - a) Do not air condition where ventilation will suffice in tempering steam rooms.

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3. Disallowed:
  - a) Do not select unit from manufacturer's catalog rating. See above.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Heat exchangers shall have a BIM family provided within the BIM model.

### 3. PRODUCT REQUIREMENTS

- A. Steam-to-water heat exchanger:
  1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Bell and Gossett
      - 2) Armstrong
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Heat exchanger: Multi-pass, U-tube; steel shell, 125 psi W.P.; ASME Stamp label steam in shell, water in tubes.
      - 2) Copper tube 5/8 inch outer diameter or larger, 125 psi W.P.; removable tube bundle; cast iron divided head with matching flange and with non-asbestos gaskets.
      - 3) Steel tube sheets and baffles
      - 4) Attached metal name plate stating pressure rating and size of exchanger.
      - 5) Shell of heat exchanger shall have 3/4 in NPT vacuum breaker installed in the designated connection.
      - 6) Equipment schedule shall designate number of tubes per pass, number of passes and total exchange surface.
      - 7) Support frame and saddles shall be steel that is galvanized or painted to protect it from corrosion.
    - b) Preferred: No preferences
    - c) Disallowed: None
- B. Refer to Section 22 3500 for information on steam-to-water heat exchangers for domestic hot water.

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  1. Gages shall be 3" minimum and placed in a manner that are easily visible from the service area.
  2. Frame for support of heat exchanger and associated equipment shall be installed so as to not interfere with the service of the equipment and be structurally sound.
  3. Steam traps shall be piped with unions to allow removal and installed in such a manner as to allow ease of removal.

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4. Ensure that full tube clearance is available without significant disturbance to adjacent piping or equipment, including valves and instrumentation at these HX connection points.
  5. Safety pressure relief valves shall be provided and installed on the leaving water side of these systems.
  6. Heat exchanger and associated piping shall be insulated.
- B. Preferred: No preferences
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Heat Exchangers.
- B. Documentation required:
1. Test reports: Testing, Adjusting, and Balancing.
  2. Commissioning report.
  3. ASME stamp: Steam-containing Heat Exchangers.
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 6400 PACKAGED WATER CHILLERS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 13 4800, 23 0000, 23 2113, 23 2116, and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) The following chiller types shall be used based on size of chiller:

Size	Chiller Type	Comments
<300 tons	Water-cooled screw/scroll	These types of chillers are not acceptable if intent is to connect onto and supplement the campus central chilled water loop/utility.
≥300 tons	Water-cooled centrifugal	
* Note that capacities listed are nominal tonnage. These may vary based on chiller type and manufacturer.		

- b) The engineering design consultant shall analyze the chiller bids and make a recommendation prior to the Mechanical Contractor committing to any chiller manufacturer.
- c) Chiller efficiency and scheduled selection shall be based on chiller load profile according to its intended use, lead, lag, or standby and the overall chiller plant application part load values (APLV). If the APLV is not known, then the Engineer shall use the integrated part load value (IPLV) to evaluate the plant. Fixed and variable speed drives shall be considered.
- d) Size chillers so that when one unit is out, the remaining units shall provide 70% of the anticipated block load. Consideration for load profile will be given when proposing to deviate from this requirement.

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- e) Chiller selection and design shall allow for a primary variable operation and an 18-20°F temperature drop across the evaporator for chillers that are intended to be connected onto and become part of systems that make-up and supplement the campus central loop/utility.
  - f) Provide an expansion tank and air separator on all chilled water systems. Air separator to be located in the piping on suction side of pump. If building chillers to be connected onto and supplement the campus, expansion tank shall be piped and means shall be provided so it can be divorced from system when chiller is not in stand-alone mode, in which case system expansion is addressed centrally.
  - g) On primary/secondary piping arrangements, locate the de-coupler loop upstream of the takeoff to the first set of secondary pumps. De-coupler loop length is to be minimized, but no less than 6 equivalent piping diameters. Locate a temperature sensor in the middle of the de-coupler pipe. The maximum pressure drop through the de-coupler pipe at maximum flow is not to exceed 1.5 ft head (total).
  - h) Appropriate structural and architectural building systems shall be accounted for and installed to allow for future removal and potential replacement of packaged water chiller equipments. At minimum, means for disassembly of the largest equipment components shall be accounted for, along with consideration for rigging of such equipments.
  - i) Design of refrigeration room shall adhere to local code and ASHRAE or other appropriate industry guideline to provide means and systems for proper ventilation and space pressurization control during normal and purge operating modes.
  - j) Water storage (often in the form of storage/buffer tank) shall be provided as to supplement the piping system, so to assure manufacturer recommended minimum chiller volume requirements to maintain minimum loop time. This loop time shall not be below 5 minutes.
  - k) Provisions for connection of temporary chilled water systems, sized to match full design requirements, shall be accounted for. See installation requirements for additional associated criteria.
  - l) Perform electrical short circuit analysis to properly validate rating and type of starter, as appropriate and applicable.
2. Preferred:
- a) Primary/secondary pumping or variable speed pumping shall be considered where there are three or more chillers.
    - 1) Coordinate further preferences with USC where chillers are designed to be a source plant to the overall campus central chilled water loop.

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- B. Quality Assurance requirements beyond standard 1 year warranty: 5-year labor and parts for complete unit.
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Chillers shall have BIM families provided within the BIM model, inclusive of motors, VFD (if onboard), accessories, and controller information.

### 3. PRODUCT REQUIREMENTS

- A. Water chillers:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Trane
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide interactive control interface adjacent to machine. Interface shall have capability of monitoring and maintain full local control/operation of machine operation, along with diagnostic capabilities.
      - 2) Provide appropriate control modules so specific control and monitoring points can be hardwired directly from equipment to Building Automation System including start/stop, stats, and alarm. Coordinate with FPM Facilities for identification of specific points required.
      - 3) The entire system shall be capable of being monitored by the campus BMS interface and all data shall be provided in an open protocol with all necessary BacNet or Modbus gateways provided free of charge.
      - 4) Provide factory-applied insulation over all cold surfaces.
      - 5) Hinged water boxes on the condenser side.
      - 6) Condenser tube sheet and head coating with approved product
    - b) Preferred:
      - 1) Where applicable, chiller starters (including where VFDs specified) shall be unit mounted on chiller by manufacturer.
      - 2) Consider using chillers with variable frequency drives for increased operating efficiency.
      - 3) Hinged water boxes on the evaporator side.
    - c) Disallowed: None
- B. Refrigeration detection system:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Honeywell - Vulcain
      - 2) Genesis International - Sherlock
    - c) Disallowed: None
  - 2. Component Characteristics:



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- a) Required:
  - 1) Refrigerant detection system shall be specified for the anticipated refrigerant to be utilized in the refrigerant machinery room.
  - 2) System shall be integrated and tied into fire alarm system, as dictated by appropriate code sections.
  - 3) Provide UPS backup power and emergency power to refrigerant detection system. Coordinate with electrical engineer for provisions.
- b) Preferred: No preferences
- c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Provide low point piping, valves, and appropriate drains directly off chiller equipment or in piping directly adjacent to tube points of connection to allow for drainage.
  - 2. Final piping connections to chiller barrels shall be done with braided stainless steel piping connections. Any other means shall be submitted for approval.
  - 3. Flanges or mechanical grooved couplings are required within connecting pipes to individual evaporator and condenser bundles to accommodate swing-away or break-away applications for maintenance access of evaporator and condenser tubes. Note that breakaway piping at tube-pull application is the only application in which mechanical grooved couplings are allowed.
  - 4. Refrigerant relief piping shall be hard piped (rigid) out to atmosphere and terminated at code appropriate location. At the point of connection to the rupture disk, provide flexible metal type connections.
  - 5. Maintain manufacturer's guidelines for minimum clearances.
  - 6. Account for adequate space above and adjacent to large equipment components (compressors, drives, etc.) to allow for clearances needed to erect and utilize rigging equipment and the means for removing these components for future service or replacement.
  - 7. Provide enough clearance (on at least one end of machine) so that access to tube sheets and ability to achieve full tube pull, on both condenser and evaporator sides, may be accomplished.
  - 8. Install electrical conduits and wiring so as to not hinder and interfere with serviceability of the machine by infringing on regions around machine requiring access clearances.
  - 9. Install refrigerant detection control panels and system related accessories in accordance with local code and appropriate ASHRAE guideline through a coordinated effort with a combination of the project Electrical (Division 26), Controls/Low Voltage, and Fire Alarm contractors.
  - 10. Provide independent sensors for BMS system for redundancy to verify chiller sensor readings to measure the following:
    - a) CHW supply and return temperature in/out
    - b) Differential pressure across evaporator and condenser
    - c) Separate measuring devices to measure flow and other parameters needed to calculate kw/ton
  - 11. Refer to Section 13 48 00 for noise and vibration considerations.
  - 12. Include provisions to serve building design loads, or full plant capacity (where serves multiple buildings) with temporary systems. This shall include additional

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pipng and valving, allowing for quick connection of temporary chilled water systems. Where full building line size, or where CHW plant supply line size exceeds 8", headers with multiple connections (in any combination of 4", 6", and 8") shall be included. Individual connections shall include line size isolation valves and flanged 12" spool pieces as the point of connection for temporary systems. Locate and design these provisions, so to allow for the utilization of base building / plant pump systems, along with temporary chillers.

- B. Preferred: No preferences
- C. Disallowed:
  - 1. Rubberized products for final piping connections to chiller barrels and for connections from rupture disk to refrigerant relief piping are not allowed.
  - 2. Control or monitoring accessories and related instrumentation shall not be allowed in sections of pipe downstream of local system isolation valves.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Chiller, Refrigerant Detection System.
- B. Documentation required:
  - 1. Test reports: Testing Adjusting and Balancing.
  - 2. Commissioning report.
  - 3. In-person witnessing for Field test results:
    - a) Initial state Eddy Current analysis of tubes.
  - 4. Factory test results: Factory test for performance and sound.
    - a) Extent of performance scenarios to be coordinated with USC.
  - 5. UL listing: Chiller.
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**

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## 23 6403 PACKAGED AIR COOLED CHILLERS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 13, 4800, 23 0000, 23 2113, 23 2116, 23 2123, and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) The following chiller types shall be used based on size of chiller:

Size	Chiller Type	Comments
<150 tons *	Air-cooled scroll	These types of chillers are not acceptable if intent is to eventually connect onto and supplement the campus central chilled water loop/utility.
150-250 tons *	Air-cooled helical rotary/screw	These types of chillers are not acceptable if intent is to eventually connect onto and supplement the campus central chilled water loop/utility.
* Note that capacities listed are nominal tonnage. These may vary based on chiller type and manufacturer.		

- b) The engineering design consultant shall analyze the chiller bids and make a recommendation prior to the Mechanical Contractor committing to any chiller manufacturer.
- c) Chiller efficiency and scheduled selection shall be based on chiller load profile according to its intended use, lead, lag, or standby and the overall chiller plant application part load values (APLV). If the APLV is not known, then the Engineer shall use the integrated part load value (IPLV) to evaluate the plant. Fixed and variable speed drives shall be considered.

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- d) Select evaporator temperatures and range to provide optimal performance for chiller system, piping system and heat transfer system (i.e. performance of coils, heat exchangers, etc.).
  - e) Provide an expansion tank and air separator on all chilled water systems. Air separator to be located in the piping on suction side of pump.
  - f) Review pumping arrangement – primary/secondary, primary/variable, etc. – with USC. For primary/secondary piping arrangements, locate the de-coupler loop upstream of the takeoff to the first set of secondary pumps. De-coupler loop length is to be minimized, but no less than 6 equivalent piping diameters. Locate a temperature sensor in the middle of the de-coupler pipe. The maximum pressure drop through the de-coupler pipe at maximum flow is not to exceed 1.5 ft head (total).
  - g) Appropriate structural and architectural building systems shall be accounted for and installed to allow for future removal and potential replacement of packaged water chiller equipments. At minimum, means for disassembly of the largest equipment components shall be accounted for, along with consideration for rigging of such equipments.
  - h) Water storage (often in the form of a storage/buffer tank) shall be provided to supplement the piping system to meet the manufacturer's recommended minimum chiller volume requirements to maintain the minimum loop time. This loop time shall not be below 5 minutes.
  - i) Provisions for connection of temporary chilled water systems, sized to match full design requirements, shall be accounted for. See installation requirements for additional associated criteria.
  - j) Perform electrical short circuit analysis to properly validate rating and type of starter, as appropriate and applicable.
  - k) Refer to 23 0000 for requirements related to ambient air temperatures for sizing outdoor condensers.
2. Preferred:
- a) Primary/secondary pumping or variable speed pumping shall be considered where there are three or more chillers.
  - b) Size chillers so that when one unit is out, the remaining units shall provide 70% of the anticipated block load. Consideration for load profile will be given when proposing to deviate from this requirement.
- B. Quality Assurance requirements beyond standard 1 year warranty: 5-year labor and parts for complete unit.
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Chillers shall have BIM families provided within the BIM model, inclusive of motors, VFD (if onboard), accessories, and controller information.

### 3. PRODUCT REQUIREMENTS

- A. Air cooled chillers:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Trane

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- 2) York
  - 3) Carrier
  - 4) Daikin-McQuay
2. Component Characteristics:
- a) Required:
    - 1) Provide interactive control interface adjacent to machine. Interface shall have capability of monitoring and maintain full local control/operation of machine operation, along with diagnostic capabilities.
    - 2) Provide appropriate control modules so specific control and monitoring points can be hardwired directly from equipment to Building Automation System including start/stop, stats, and alarm. Coordinate with FPM Facilities for identification of specific points required.
    - 3) The entire system shall be capable of being monitored by the campus BMS interface and all data shall be provided in an open protocol with all necessary BacNet or Modbus gateways provided free of charge.
    - 4) Provide factory-applied insulation over all cold surfaces.
  - b) Preferred:
    - 1) Where applicable, chiller starters shall be unit mounted on chiller by manufacturer.
    - 2) Consider using chillers with variable frequency drives for increased operating efficiency.
    - 3) Consider specifying anti-corrosion coatings on condenser coils/fins. Products shall be one of the following: PVC, Heresite or Electrofin.

## 4. INSTALLATION REQUIREMENTS

- A. Required:
1. Provide low point piping, valves, and appropriate drains directly off chiller equipment or in piping directly adjacent to tube points of connection to allow for drainage.
  2. Final piping connections to chiller barrels shall be done with braided stainless steel piping connections. Any other means shall be submitted for approval.
  3. Flanges or mechanical grooved couplings are required within connecting pipes to individual evaporator connections.
  4. Maintain manufacturer's guidelines for minimum clearances.
  5. Account for adequate space above and adjacent to large equipment components (compressors, drives, etc.) to allow for clearances needed to erect and utilize rigging equipment and the means for removing these components for future service or replacement.
  6. Install electrical conduits and wiring so as to not hinder and interfere with serviceability of the machine by infringing on regions around machine requiring access clearances.
  7. Provide independent sensors for BMS system for redundancy to verify chiller sensor readings to measure the following:
    - a) CHW supply and return temperature in/out
    - b) Differential pressure across evaporator and condenser

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- c) Separate measuring devices to measure flow and other parameters needed to calculate kw/ton
  - 8. Refer to Section 13 48 00 for noise and vibration considerations.
  - 9. Include provisions to serve building design loads, or full plant capacity (where serving multiple buildings) with temporary systems. This shall include additional piping and valving, allowing for quick connection of temporary chilled water systems. Where full building line size, or where CHW plant supply line size exceeds 8", headers with multiple connections (in any combination of 4", 6", and 8") shall be included. Individual connections shall include line size isolation valves and flanged 12" spool pieces as the point of connection for temporary systems. Locate and design these provisions, so to allow for the utilization of base building / plant pump systems, along with temporary chillers.
- B. Preferred: No preferences
- C. Disallowed:
- 1. Rubberized products for final piping connections to chiller barrels and for connections from rupture disk to refrigerant relief piping are not allowed.
  - 2. Control or monitoring accessories and related instrumentation shall not be allowed in sections of pipe downstream of local system isolation valves.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Chiller, Refrigerant Detection System.
- B. Documentation required:
- 1. Test reports: Testing Adjusting and Balancing.
  - 2. Commissioning report.
  - 3. In-person witnessing for Field test results:
    - a) Initial state Eddy Current analysis of tubes.
  - 4. Factory test results: Factory test for performance and sound.
    - a) Extent of performance scenarios to be coordinated with USC.
  - 5. UL listing: Chiller.
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 6500 COOLING TOWERS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 64 00, 23 21 13, 23 21 16, 23 25 00 and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Based on trend data gathered locally by USC weather station and FPM Facilities operations staff, design wet bulbs in the vicinity of the UPC and HSC campuses have been found to be as high as 78°F. Where this contradicts with industry guidelines or Title 24 appendix information, this value shall prevail as the basis for selection of these systems.
    - b) Piping arrangement for cooling towers shall be designed such that flow to and from the tower is hydraulically balanced to ensure equal flow distribution to and from each tower cell.
    - c) Provide a condenser water pump dedicated to each chiller within the chilled water plant. Provide manual cross-over valves and headering to allow each pump to serve as a backup to other system pumps and support any chiller in overall system.
    - d) Coordination of cooling tower basin sweeper/filter system and the proposed pipe distribution/placement of nozzles within the cooling tower basin shall be done along with the manufacturer representatives of both systems. Submit proposed shop drawings of proposed basin pipe distribution for review by FPM Engineering prior to 100% Design Development.
    - e) Tower manufacturer shall provide sound level data for analysis by an acoustical engineer. The design team shall present the analysis to FPM Engineering for review prior to 100% Design Development completed.
    - f) Refer to Section 13 48 00 for noise and vibration considerations.
  - 2. Preferred: No preferences
  - 3. Disallowed: None

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- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Cooling towers shall have a BIM family provided within the BIM model, inclusive of fans, motors and VFD information (if onboard VFD is provided).

### 3. PRODUCT REQUIREMENTS

- A. Cooling towers:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Baltimore Air Coil
      - 2) Marley
    - c) Disallowed: Any Other Alternative
  - 2. Component Characteristics:
    - a) Required:
      - 1) Wetted section of tower shall be (Type 316) stainless steel.
      - 2) Non-wetted section of tower shall be (Type 304) stainless steel.
      - 3) Provide each fan section that makes up a modular cooling tower system with a variable frequency drive when motor is 7.5 Hp or greater.
      - 4) Provide adequately sized equalizer line with valves to permit each lower basin to be isolated for cleaning.
      - 5) Manufacturer shall engineer and furnish a sweeper system including pumps, filtration, piping, and nozzles for the specific application. Provide available gateway interface for interconnection with USC BMS.
      - 6) Provide electronic basin level control and capability for monitoring and mechanical level control. BMS shall monitor basin level status.
      - 7) Provide flow meter connected to central BMS to measure make-up water usage. Meter shall be specified with a dual output relay and shall connect to both the central BMS and the chemical treatment controller.
      - 8) Provide flow meter connected to central BMS to measure blow-down from condenser water system. Meter shall be specified with a dual output relay and shall connect to both the central BMS and the chemical treatment controller.
      - 9) Provide tower with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection. The vibration cut out switch shall be tied into local fan control equipment. Provisions shall be provided so this point is monitored by BMS.
      - 10) Where towers made up of multiple cells, provisions shall be included to allow for the isolation and maintenance of each cell independently, without requiring a shutdown of the entire system.



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- 11) Manufacturer provided equipment davit to facilitate removal and rigging of equipment (fan motors, etc.). If not provided by manufacturer, a suitable davit system shall be designed and specified.
- b) Preferred:
  - 1) Entire body of tower to be (Type 316) stainless steel.
  - 2) Where systems deemed critical to the campus or part of a building deemed critical, provide redundant means (both a mechanical and an electronic means) of tower level control.
- c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  1. Provide internal or external ladders, walkways, service platforms, and guardrails as factory-mounted accessories for proper maintenance access.
  2. Provide additional equipment davit(s) on cooling tower service platform (as applicable) to facilitate removal and rigging of equipment (fan motors, etc.) up and down from grade or roof level.
  3. Provide isolation for each cooling tower cell by means of BMS and two-way control valves to allow for quick shutdown and maintenance on an individual tower while maintaining operation of the remaining towers. Isolation required for supply, return, and equalizer.
  4. Provide blow out flanges at each end of equalizer line to allow for the removal of the piping for sand cleaning and flushing trapped in line.
  5. In addition to the tower basin, and in order to avoid the build-up of sedimentation due to stagnation of water, provide connections to the sweeper/filter system at the following locations (including isolation valves at each point).
    - a) At each main connection leaving the tower from the respective basin(s).
    - b) At minimum, two equally spaced connections to the equalizer line
  6. Instrumentation necessary to monitor vibration and direct tie in to fan controller for shutdown when exceeding acceptable thresholds.
- B. Preferred: No preferences
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Cooling Tower
- B. Documentation required:
  1. Test reports: Testing, Adjusting, and Balancing.
  2. Commissioning report.
  3. Factory test results: CTI ATC-105 test results.
  4. Onsite test results: Dynamic balancing test reports. Automatic fill operation report  
UL listing: Cooling Tower.

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- C. Required testing protocols beyond normal Commissioning and TAB protocols:
  - 1. Operate cooling tower and field adjust vibration switch sensitivity. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
  - 2. Verify that automatic fill valve responds properly to low and high water levels, and adjust limits as necessary.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 7323 CUSTOM CENTRAL-STATION AIR-HANDLING UNITS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document. For other related requirements, refer to Sections 23 0513, 23 0514, 23 3400, 23 4000, 23 8413, 23 8216, 23 3113, 23 2113, 23 2116 and independent controls guidelines.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

- C. Additional Information: The scope below shall cover both indoor and outdoor air handling units. Any units installed outdoors shall be specifically designed for outdoor use and shall have standing seam construction, a pitched roof to ensure rain runoff and all panels caulked to be water tight. Outdoor units shall have a hinged weather hood over the filter gauge and NEMA 3R enclosures for VFDs.
- D. The following shall be considered minimum standards, yet designers shall apply these standards appropriately and expand upon them when specifying this equipment for critical or specialty environments, in which case stricter standards may be applied.

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
1. Required:
    - a) All air handling units shall be custom units.
    - b) Perform electrical short circuit analysis to properly validate rating and type of starter, as appropriate and applicable.
    - c) The following standards on subcomponents shall prevail:
      - 1) Exterior finish paint to have passed Salt Spray Resistance Test ASTM B-117-90 minimum 1000 hours, Impact Test ASTM D-2794-90 up to 160 lbs and Humidity Resistance Test ASTM D2247-87 minimum 1000 hours test with maximum blister 1/16 in/1 mm.
      - 2) Fabrication: Conform to AMCA 99 and ARI 430.
      - 3) Fan Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.
      - 4) Fan Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
      - 5) Motors shall be tested to IEEE Standard 112 test method B and NEMA MG 12.58.2 and 12.59 table 12-10.
      - 6) Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410.

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- 7) Louvers: shall bear an AMCA Certified Ratings Seal in accordance with AMCA 500.
- 8) Humidifiers: Capacities and selection in accordance with ARI 610.
- d) Provide structure to brace casings to achieve a maximum deflection of 1 in 200 for the greater of anticipated system pressures or the following criteria:
  - 1) Suction pressure of at least 2.5 inch wg
  - 2) Supply discharge pressure of at least 6 inch wg.
- e) Floor and base of unit shall have a maximum 1/8 inch deflection.
- f) For duct connections through the floor, provide steel or aluminum walking grate on structural supports.
- g) Motors shall be 1750 rpm.
- h) When belt drive equipment is used, variable and adjustable pitch sheaves for motors 10 Hp and under shall be selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for greater than 10 Hp, matched belts and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.
- i) Factory mount motor on slide rails. Mount fan and motor on independent welded structural steel base. Mount independent base on vibration isolators for connection to Air Handling Unit's structural steel frame.
- j) Provide access to both sides of coils.
- k) Slide coils into coil casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- l) Damper Leakage: Maximum 2 percent at 4 inch W.G. differential pressure when sized for 2000 fpm face velocity.
- m) Fans shall be supplied with a flow measurement system that provides pressure measurements to pressure transmitter provided by BMS contractor. The manufacturer must select the fan to compensate for any effect that this measurement system has on flow, static pressure or sound power.
- n) All unit controls conduit distribution and device infrastructure shall be factory mounted and shall interface with the university standard Energy Management System (see independent controls guideline). At minimum this distribution shall include continuous 1" conduit throughout entire length of air handler, with junction boxes provided at each section of these units.
- o) All unit fire / life safety conduit distribution and device infrastructure shall be factory mounted and coordinated to interface with the existing or proposed building fire alarm system. At minimum this distribution shall include continuous 3/4" conduit throughout entire length of air handler, with junction boxes provided at each fan section.
- p) Provide factory mounted entry pathways for controls and fire/life safety conduit distribution, so to avoid field penetrations into air handling unit.
- q) Design of air handler base shall take into account the future anchorage requirements. A strategy shall be developed to avoid field welding of anchorage plates (where possible) or otherwise provide a plan to not compromise the factory coating when anchorage activities are taking place.
- r) All systems shall be laid out to allow for unobstructed full coil pull along one side of the air handler. Engineer shall present explicit plan and procedure by which coils are pulled in future retrofit applications and identify details in air handler construction and piping arrangements to allow this to happen in a way that minimizes interference with piping and piping supports and does not require a complete hydronic system shut-down.

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- s) Designers shall coordinate the selection of related fire/life safety devices to be compatible with the existing fire alarm system type and capability.
  - t) Where smoke detectors are factory furnished and mounted, they shall be powered from a source independent to the air handling unit and other unit appurtenances.
  - u) Smoke detectors installed for the purpose of shutting down fan systems (not part of smoke control systems), shall be specified with an auxiliary means of being monitored by the BMS. This shall not impact the primary monitoring or control of this device when connected to building fire alarm.
  - v) Provisions for fan section door switches / contacts, to be interlocked with local motor controller for shut down of fan system when opened.
    - 1) To accomplish requirement, overall wiring diagram shall be coordinated, accounting for the pre-wiring of the air handling unit and the proper means for terminating onto the local motor controller.
  - w) Do not use clean filter pressure drops in internal AHU static pressure calculations. Add columns for clean and dirty filter pressure drop data in AHU schedule.
2. Preferred:
- a) Coil pull clearance shall be on the opposite side of coil connections to avoid significant re-piping.
  - b) Air handling unit smoke detectors to be factory furnished and mounted, with the appropriate enclosures and a dedicated conduit pathway throughout.
3. Disallowed:
- a) Modular air handling units.
  - b) Fan Motors shall not be selected in the service factor.
  - c) VFD shall not be selected to operate above 60Hz.
  - d) Use of air handler vendors that have lead-times that will impact project schedules, when compared to other approved vendors.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Air handlers shall have a BIM family provided within the BIM model, inclusive of motors, VFD, coil, filter and humidifier (if present) information.

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### 3. PRODUCT REQUIREMENTS

#### A. Air Handling Unit:

##### 1. Manufacturers:

###### a) Required:

- 1) Air handler:
  - i) Temtrol
  - ii) Thermal
  - iii) Haakon
  - iv) Huntair
  - v) Climate Craft
  - vi) Energy Labs
- 2) Pre-filters: Flanders FAP-300 Series: Flat 2 inches deep, 30% efficiency (MERV-8 minimum) per ASHRAE standard 52.1.
- 3) Primary filters: Aerostar FP Series 12" deep, 95% efficiency (MERV-14 minimum) per ASHRAE standard 52.1.
- 4) Filter holding frame: Burke Environmental Astr-Frame Model ASF (304 SS).
- 5) Filter frame sealant: DOW 732 silicone sealant.
- 6) Filter Gage: Dwyer Model 2002 AF.
- 7) Provide a physical space between pre-filters and primary filter to allow independent pressure differential sensors for each filter bank.
- 8) Coordinate current air handler lead-times with the project schedule. Utilize an air handler manufacturer, as the basis of design, which also meets project schedule requirements.

##### 2. Preferred:

- a) Louver: Ruskin
- b) Dampers: Ruskin

##### 3. Component Characteristics:

###### a) Required:

- 1) Provide either bolted panel construction or unit with integral tubular frame. Fabricate on welded tubular steel or structural steel channel
- 2) Assemble sections with gaskets and bolts or fasteners.
- 3) Panels are to be removable.
- 4) The floor shall be either attached to the structural members below with cad-plated neoprene washered drive screws or shall be continuously welded.
- 5) Air handling unit structural frame shall be elevated a minimum of 12" above finished floor or roof or at an elevation to allow proper trapping of condensate, whichever is greater.
- 6) Refer to Section 23 0514 for VFD mounting height.
- 7) OSA Intakes: Provide (2) dampers on outside air intake, one sized for minimum outside airflow plus 10%, one sized for the remainder of flow to achieve economizer flow. Provide outside air extensions on outdoor units to allow for proper installation of outside air monitoring sensors. Provide a factory mounted cover over outside air intakes to protect from rain intrusion.
- 8) Unit Construction materials shall be as follows:

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<b>Unit Construction</b>		
<b>Location</b>	<b>Material</b>	<b>Comments</b>
Outside Casing	16 ga. G90 Galvanized	Finish to be Polyceram 3200, powder coated finish-baked at 375 degree F or air dried Carboline Polyurethane.
Inside Casing except fan section	20 ga. G90 galvanized, solid	
Inside Casing for fan section	22 ga. G90 galvanized, perforated	
Insulation	Neoprene coated, glass fiber, Minimum 2 inch thick, 3 lbs/cu ft. "K" value (at 75°F) ≥ 0.26 Btuh/(inch.sq ft.°F)	Attach with adhesive and weld pins with exposed edges of insulation coated with adhesive
Floor	16 ga. G90 galvanized steel with 20 ga. Galvanized steel underliner	Provide a minimum of 4" thick insulation, "K" value as noted above.
Base structure, fan bases, springs and structural steel supports	As noted elsewhere.	Shall be painted with an industrial DTM finish with built-in rust inhibitors
Walk-in Access Doors	Minimum 24 inch wide, flush-mounted, galvanized steel insulated sandwich construction. Door frame shall be extruded aluminum and incorporate a built-in thermal break barrier.	Provide 12 X 12 inch inspection window of 1/4 inch thick plexiglass or dual thermal pane. Hinges, gasket, latch and handles shall operable from both sides. Access doors into fan compartments shall have a tool operated safety latch, complying with Title 8 CAL-OSHA, ETL and the mechanical protection requirements of UL 1995.
Drain pans under cooling coil section and humidifier section	16 gage stainless steel type 304 inner liner, 20 gage G-90 galvanized under liner with insulation between.	Provide double sloped IAQ drain pan, pitched to single drain connection. Provide welded corners. Provide for length of 24 inch downstream of coil.

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<b>Unit Construction</b>		
<b>Location</b>	<b>Material</b>	<b>Comments</b>
		Provide copper down spouts and intermediate drain pan for cooling coil banks more than one coil high
Lights for all accessible sections	Suitable for damp locations with wire guards.	Factory wire to exterior mounted 0-6 hr push button timer, adjacent to supply fan door.
Receptacles at all light switches	One GFI 120V duplex outlet mounted on casing exterior next to lighting twist timer.	Lights and duplex outlet must be on a separate 120V/single phase power circuit than power to the unit.
Louvers	Stationary, drainable, galvanized steel, 4 inch deep.	Provide bird screen in aluminum frame consisting of 1/2 inch mesh, 0.04 inch thick galvanized wire.

9) Unit Components shall be as follows:

<b>Unit Components</b>		
<b>Location</b>	<b>Material</b>	<b>Comments</b>
Filter Gage	3½ inch diameter diaphragm actuated dial in metal case with static pressure tips.	Gage to be mounted flush-faced to exterior of unit.
Filter frames (Refer to 23 40 00 for filters)	Upstream Face-loading "built up bank type". All welded 16 gage 304 stainless steel construction.	Filter section shall consist of individual holding frames that are factory assembled into a multi frame filter bank. Assembling of frames shall be accomplished with use of stainless steel screws and nuts. Welds shall be continuous on all matching joints and miters. All raw edges shall be deburred. Gasketing shall be applied to the perimeter of each holding frame. Filters shall compress gasket under positive pressure under normal flow. Also provide clamping assembly to hold filters in place. Provide space between filter frames for



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<b>Unit Components</b>		
<b>Location</b>	<b>Material</b>	<b>Comments</b>
		independent dP sensors.
Prefilters	Disposable extended area panel filters.	UL 900 listed, Class I or Class II, approved by local authorities.
Final filters	Low-resistance mini-pleat, V-bank rigid filter	UL 900 listed, Class I or Class II, approved by local authorities.
Fan	Air foil, Backward inclined single width, single inlet, centrifugal plug type fan. Refer to Section 23 34 00 for more requirements.	Provide AMCA arrangement 1 with unobstructed inlet. Provide plug fan inlet screen and protective enclosure around fan wheel, with access into unit for motor, drive and bearings. Provide flexible duct connection between fan and inlet wall opening. See design criteria for mounting configuration requirements.
Fan Bearings	Self-aligning, grease lubricated, ball or roller bearings	Extend lubrication to exterior of casing with plastic tube and attach grease fitting rigidly to casing.
Motors	Premium efficiency TEFC, NEMA Design B T-Frame motors, cast iron frame, inverter duty rated if provided with VFD (see section 23 05 13 and 23 05 14 for more for requirements).	Motors shall be wired to an external junction box. Motors shall have shaft bearing grounding kits installed to prevent excessive bearing wear due to VFD operation. See design criteria for mounting configuration requirements.
Motor Bearings	Heavy duty pillow block type, self-aligning, grease-lubricated ball bearings	Provide bearings with ABMA 9 L-10 life of 200,000 at design operating conditions.
Shafts	Solid, hot rolled steel, ground and polished, with key-way and protectively coated with lubricating oil.	
V-Belt Drive	Cast iron or steel	See design requirements for

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Unit Components		
Location	Material	Comments
(if belt driven)	sheaves, dynamically balanced, bored to fit shafts and keyed.	belt drives above.

Belt Guard (if belt driven)	0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated.	Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication and use of tachometer with guard in place.
Hydronic Preheat and Cooling Coils	Serpentine type. Die formed channel frame 16 gage 304 stainless steel casing. Seamless copper tube drainable header. Tubes: 5/8 inch OD seamless copper, 0.020 thickness, expanded into fins, brazed joints. Fins: Copper, 0.008 thickness, or an aluminum fin with approved means of coating. Refer to 23 82 16. Coils are to be provided with factory coating.	Headers and return bends are to be fully contained within casing. Pipe 1/8 inch header vent and header drain connections to outside of unit. Return bends shall be a minimum of one tube thickness greater than the main tubes. See 23 8216 for coil performance selection methodology.
Humidifier Dispersion Grid (as required)	Stainless steel distribution tube with evenly spaced orifices extended full width of unit	Factory- mount in plenum for draw-through units or diffuser section of blow-through units. See also 23 84 13.
All Dampers	Factory-mounted Airfoil, extruded aluminum blades and santoprene rubber edge seals,	Provide dampers in parallel blade arrangement.

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	16 gage galvanized frame, stainless steel side jamb seals with stainless steel or zinc plated tubular square shafts, self-lubricating nylon non corrosive bearings	
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- b) Disallowed:
- 1) Formed metal bases are not acceptable.
  - 2) Riveted or spot welded panels are not acceptable.
  - 3) Welding or riveting of filter frames is not acceptable.

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. Provide hydronic piping supply and return temperature sensors connected to the BMS at the air handling unit coil connections. Where supply and return temperature sensors exist at either the building connection from the campus loop or at the building cooling or heating system, only a temperature sensor on the return piping from the air handling unit coil needs to be provided.
2. A separate 120V/single phase power circuit shall be provided in the field by the electrical contractor to connect to the light/receptacle circuit of the air handling unit. Lighting shall be controlled via a pushbutton 0-6 hour timer housed in a weatherproof enclosure.
3. Install unit in accordance with ARI Guideline D and in accordance with manufacturer's instructions.
4. Bolt sections together with gaskets.
5. Do not operate units until ductwork is clean, filters are in place, bearings are lubricated, commissioning pre-functional test procedures are complete, fan has been test run under observation by manufacturer start-up technician and all start-up and pre-functional documentation has been reviewed and approved by USC's commissioning agent.
6. Provide one set of additional filters for each unit.
7. Supply one set for each unit of fan belts.
8. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as required. Adjust snubbers to prevent tension in flexible connectors when fan is operating.
9. Provide fixed sheaves required for final air balance.
10. Make connections to coils with unions or flanges. Connect water supply to leaving air side of coil (counter flow arrangement). Provide manual air vents at high points complete with stop valve. Ensure water coils are drainable and provide drain connection at low points.
11. Insulate coil headers located outside air flow as specified for piping.
12. Connect humidifiers to water supply. Provide gate valve on water supply line. Pipe humidifier drain and overflow piping to nearest floor drain.
13. Refer to Section 23 2113 for hydronic cooling and heating coil connection

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- installation details.
14. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
  15. Where unit requires field assembly of major sections by contractor, factory witnessed, or manufacturer certified inspection shall be completed to assure proper assembly.
  16. All roof mounted air handling units shall be installed on either an elevated curb, concrete pad, or structure. All floor mounted air handling units shall be installed on a minimum 6" high concrete curb.
  17. For concrete pad applications, coordinate required air handling unit equipment pad edge distance with structural engineer to minimize unnecessary pad surface area, where ponding of water may occur.
  18. Coordinate mounting and final anchorage strategy of equipment and its base, to associated support structure, in order to avoid compromising integrity of factory exterior finish due to welding or other field modifications when anchoring this equipment. Any welding of stiffeners, anchor plates, etc.; shall be done prior to unit arriving on site and done so to avoid damaging base rail of cabinet of AHU.
  19. Temporary filtration for units, through construction and startup, shall be accounted for and provided for both new and retrofit installations.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Air Handling Unit Start-up required by factory representative or factory certified representative.
- B. Documentation required:
  1. Test reports: Testing Adjusting and Balancing.
  2. Commissioning report.
  3. Factory test results: Cabinet leakage test, Laboratory sound test.
  4. UL or listing: Entire unit shall be UL or E.T.L. listed.
  5. Factory Technician Start-up report
- C. Required testing protocols:
  1. Unit manufacturer shall provide a factory leak test on one unit at design operating static pressure. Cabinet leakage shall not exceed 1% of design flow rate at 12" WG. Manufacturer shall furnish a written report to the engineer.
  2. The unit manufacturer shall test one unit at an AMCA accredited laboratory. Sound testing using a sound intensity meter is not acceptable. The unit shall be tested per AMCA 300-85 Unit Discharge and Return Sound Power Tests and Cabinet radiated Sound Power Test. A written report shall be provided showing the test results and the test methods used. The octave band sound power levels shall be determined via the reverberant room method in accordance with the latest version of ARI 260 or AMCA 300 standard in an AMCA certified laboratory. An alternate procedure approved by and details agreed to by the project acoustical consultant is also acceptable when based according and traceable to national or international standards. When submitting an alternate procedure, the alternate procedure shall be submitted with the first air handler submittal to allow for extra time in review by the project acoustical consultant. In addition, the

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manufacturer who is proposing the alternate procedure shall simultaneously submit a letter that agrees to pay for the project acoustical consultant's time and material fee up to a maximum of two manweeks of time to cover that amount of time related to the evaluation of the alternate procedure. Evaluation of the alternate procedure is no guarantee that it will be accepted. The decision resides solely with the project acoustical engineer as to whether the alternate procedure will be allowed. If the alternate procedure is rejected, then the AMCA certified laboratory testing specified above must be done.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 8123 COMPUTER-ROOM AIR-CONDITIONERS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13, 23 21 16, 23 31 13, 23 21 23, 23 23 00 and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Units shall be located to optimize air distribution in the server room.
    - b) If the heat-generating equipment within the room is served by emergency standby power, then the units shall be a DX type system and they shall be on emergency power. Discuss with user of room/ cooled equipment for redundancy requirements (i.e. N+1).
    - c) Contact USC project manager to confirm end user equipment heat loads and quantities
    - d) Allow for 15% growth (heat load) when calculating cooling capacity.
    - e) Coordinate water quality or source requirements with Plumbing.
    - f) The DX Computer room systems shall consist of controllers, in room temperature/humidity sensors, piping accessories, thermostatic expansion valve, and compatible condensers and in room with total system performance guaranteed by the manufacturer.
    - g) Refer to 23 00 00 for requirements related to ambient air temperatures for sizing outdoor condensers.
  - 2. Preferred: No preferences
  - 3. Disallowed:
    - a) Equipment selection which deviates/exceeds allowable temperature and pressure (drop) criteria, where served by central campus hydronic utilities.
    - b) Fan Motors shall not be selected in the service factor.
    - c) VFD shall not be selected to operate above 60Hz.

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- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Computer room units shall have a BIM family provided within the BIM model, inclusive of motors, coil, filter and controller information.

### 3. PRODUCT REQUIREMENTS

- A. Computer-room air-conditioners:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Data Aire
      - 2) APC
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) For raised floor applications, provide seismic floor stand and turning vanes for downflow units. Provide duct collar on top of unit for connection to return air plenum.
      - 2) For non-raised floor applications and no overhead air distribution, provide plenum with grille for upflow units.
      - 3) Provide unit with steam humidifier and electrical reheat unless otherwise told.
      - 4) If necessary, provide factory furnished condensate pump. Confirm if power to pump is integral or separate from AC unit.
      - 5) Provide advanced graphic microprocessor for staging control.
      - 6) Provide CRAC unit on DX type system.
      - 7) Provide head pressure controls to allow for stable unit operation at low ambient conditions.
      - 8) Provide stainless steel primary drain pans and galvanized steel secondary drain pans. Secondary drain pans shall extend beneath the unit as well as the coil connections.
    - b) Preferred:
      - 1) Provide unit with hot gas bypass.
    - c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. If the computer room air conditioning unit utilizes chilled water, provide hydronic piping supply and return temperature sensors connected to the BMS at the coil connections. Where supply and return temperature sensors exist at either the building connection from the campus loop or at the building cooling or heating system, only a temperature sensor on the return piping from the computer room air conditioning unit coil needs to be provided.

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2. Leak detection is required to be located at server room floor and to be connected to BMS for monitoring.
  3. Secondary BMS-monitored temperature sensor shall be provided in the room to provide parallel reading as compared to the CRAC unit sensor.
- B. Preferred: No preferences
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Computer Room Air-conditioners. Start-up required by factory representative or factory certified representative.
- B. Documentation required:
1. Test reports: Testing, Adjusting, and Balancing.
  2. Commissioning report.
  3. UL listing: Computer Room Air-conditioner.
  4. Factory Technician Start-up report
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**



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## 23 8126 SPLIT-SYSTEM AIR-CONDITIONERS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13, 23 21 16, 23 21 23, 23 31 13, 23 23 00, and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) The use of these types of equipment shall be limited to areas requiring 24 hour cooling operation.
    - b) For areas requiring humidity control shall refer to Section 23 81 23 for requirements.
    - c) If the heat-generating equipment within the room is served by emergency standby power, then the DX system shall be on emergency power.
    - d) The split systems shall consist of controllers, in room thermostats, piping accessories, thermostatic expansion valve, and compatible condensers and in room fan coil units with total system performance guaranteed by the manufacturer.
    - e) A dedicated split system shall be provided for each space which requires 24 hour cooling operation.
    - f) Refer to 23 00 00 for requirements related to ambient air temperatures for sizing outdoor condensers.
  - 2. Preferred: No preferences
  - 3. Disallowed:
    - a) Multi-Split” type units which serve multiple spaces with a single outdoor condensing unit, unless written approval is provided by the FPM Engineering.
    - b) Fan Motors shall not be selected in the service factor.
    - c) VFD shall not be selected to operate above 60Hz.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing

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motors. Split systems shall have BIM families provided within the BIM model, inclusive of motors, coil, filter and controller information.

### 3. PRODUCT REQUIREMENTS

#### A. Split-System Air-Conditioners:

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Carrier
    - 2) Trane
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Provide head pressure controls to allow for stable unit operation at low ambient conditions.
    - 2) Provide hot gas bypass option in single compressor equipment for low load conditions.
    - 3) Provide hot gas reheat option in equipment requiring humidity control.
    - 4) Provide a primary stainless drain pan and a secondary galvanized steel drain pan.
    - 5) Provide independent thermostat and controller.
    - 6) Refer to Section 23 2300 for refrigerant piping requirements.
  - b) Preferred: No preferences
  - c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. BMS shall provide an independent temperature sensor for monitoring located next to the split-system thermostat.
2. Hard-wired, wall mounted, thermostat shall be provided.
3. Installing contractor shall be certified by the manufacturer prior to the time of bid and shall have a minimum of 2 years experience with installing this type of system.

#### B. Preferred: No preferences

#### C. Disallowed: Installation of fan coil units above sensitive electric/electronic equipment.

### 5. EVALUATION or COMMISSIONING

#### A. List of items or systems requiring testing, evaluation, verification, or commissioning:

Required Items: Split Systems

#### B. Documentation required:

1. Test reports: Testing, Adjusting, and Balancing.
2. Commissioning report.
3. UL listing: Split Systems.

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- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**

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## 23 8145 PACKAGED VARIABLE REFRIGERANT FLOW SYSTEMS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13, 23 21 16, 23 21 23, 23 31 13, 23 23 00, 23 65 00 and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) VRF/VRV systems will be considered on replacement projects where the job site conditions are such that replacement with “like kind” or approved systems would require significant structural changes, or other major re-work, resulting in substantial occupant displacement, or if the project’s budget would be highly impacted. The A/E design team shall provide, during the assessment phase, an overall Life Cycle Cost breakdown of the VRF system as compared to other viable options. FPM Engineering will review the engineer’s assessment and provide a recommendation for the final design. Typical installations; retrofit of housing or 24 hour technical spaces.
    - b) The A/E design team shall submit a formal project request to FPM Engineering for the proposed VRF system.
    - c) The Mechanical Engineer will assume full design responsibility for VRF system selection, layout, details and coordination. The VRF manufacturer shall provide support/supervision during the following stages: design development, shop drawing development, field installation/verification, start-up and commissioning. The Engineer shall not rely solely on the design direction provided by the VRF manufacturers’ representative.
    - d) The condenser will be sized to meet the maximum block cooling load.
    - e) Refrigerant:
      - 1) The Mechanical Engineer shall include, within plans, a hazard assessment which considers a potential refrigerant leak anywhere along the proposed refrigerant pipe route. The assessment shall identify the maximum allowed refrigerant quantity, the proposed refrigerant quantity and the volume of the room(s) that may be exposed to the refrigerant leak.

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- 2) Calculations shall be performed to ensure the maximum allowed refrigerant charge is per ASHRAE Standards 15 & 34. A refrigerant chart, identifying maximum allowable refrigerant per code vs actual design quantities are to be provided on the design documents.
  - f) For areas requiring humidity control shall refer to Section 23 81 23 for requirements.
  - g) If the heat-generating equipment within the room is served by emergency standby power, the VRF/VRV system shall be on emergency power.
  - h) The systems shall consist of controllers, in room thermostats, piping accessories, thermostatic expansion valve and compatible condensers and in room fan coil units with total system performance guaranteed by the manufacturer taking into account the likely range of loadings between the multiple fan coil units
  - i) Designer shall confirm sufficient clearances are provided for the air-cooled condensers. These clearance requirements shall be clearly indicated on the construction documents.
  - j) Refer to 23 00 00 for requirements related to ambient air temperatures for sizing outdoor condensers.
2. Preferred: No preferences
  3. Disallowed:
    - a) Indoor air-cooled condensing units shall be avoided unless ducting of inlets and outlets is provided.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. VRF/VRV systems shall have BIM families provided within the BIM model, inclusive of motors, coil, filter and controller information.

### 3. PRODUCT REQUIREMENTS

- A. Variable Refrigerant Flow Systems:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Mitsubishi
      - 2) Daikin
      - 3) LG
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Project specifications shall require start-up and training by the VRF manufacturer be provided.
      - 2) The proprietary central VRF/VRV controller shall interface with the central BMS. The system shall be furnished with the necessary BACnet Broadcast Management Device (BBMD) or appropriate devices/equipment which will allow full monitoring and control to aid in system troubleshooting.

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- 3) All control points shall be accessible from the central BMS. At a minimum, the following control points shall be implemented into the central BMS:

<b>Control Point</b>	<b>BMS Interface</b>
System Enable/Disable	Full Adjustment
Supply Air Temperature (SA temp)	View
Return Air Temperature (RA temp)	View
Space Temperature	View
Space Temperature Setpoint	Full Adjustment
Filter Status	View
Fan Status	View
Compressor(s) Status	View
Economizer Damper Position (as applicable)	View
Alarm(s)	View
Any other Diagnostic points required by CEC Title 24 (automated fault detection & diagnostics, etc.)	View
Note: These control points shall be coordinated with the VRF/VRV manufacturer. The engineer is responsible for providing all associated control diagrams, control points lists and interface requirements on the construction documents.	

- 4) The system shall consist of multiple evaporators, branch selector devices, piping joints and headers, all refrigerant piping accessories, a refrigeration distribution system using PID control and an outdoor unit.
- 5) The outdoor unit shall be a direct expansion (DX), air-cooled heat pump, multi-zone air-conditioning system with variable speed driven compressors. The outdoor unit may connect an indoor evaporator capacity up to 150% of the outdoor condensing unit capacity.
- 6) All zones are each capable of operating separately with individual temperature control.
- 7) The indoor units shall be connected to the outdoor unit(s) utilizing the manufacturer specified piping joints and headers.
- 8) Operation of the system shall permit simultaneous cooling and heating of all of the fan coil units.
- 9) Refer to Section 23 23 00 for refrigerant piping requirements.
- b) Preferred: No preferences
- c) Disallowed: None

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### 4. INSTALLATION REQUIREMENTS

- A. Required:
1. Only contractors who meet the following experience criteria shall be eligible for installation and implementation of VRF/VRV systems:
    - a) Installing contractor shall be certified for installation and servicing by the specified manufacturers.
    - b) Installing contractor shall have a minimum of 5 years of experience installing VRF/VRV systems. Contractor shall submit a minimum of three (3) project references of VRF/VRV installations in the past 5 years.
  2. The system shall be designed and installed with refrigerant isolation valves that would allow servicing of individual fan coils and condensing units without the complete loss of refrigerant.
  3. Shut-down of a single fan coil unit (for service and/or repair needs) are to not affect the cooling capacity and operation of other fan coil units served by the same condensing unit.
  4. Shut-down of a single condensing unit shall not impact operation of any other associated VRF/VRV system.
  5. For 24 hour technical spaces, BMS shall provide an independent temperature sensor for monitoring located next to the in room fan coil units' VRV system thermostats.
  6. Provide condensate pump if the fan coil unit cannot drain by gravity and the unit itself does not contain an onboard condensate pump.
  7. Manufacturer's representative shall confirm in writing that the contractor's proposed installation paths for refrigerant piping and controls wiring are compatible with the stated performance of the system based on the design.
- B. Preferred: No preferences
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Condensers and Fan coil units within the Systems.
- B. Documentation required:
1. Test reports: Testing, Adjusting and Balancing.
  2. Commissioning report.
  3. UL listing: Condensers and Fan coil units within the Systems.
  4. Manufacturer's start-up technician's report verifying performance and explicitly reiterating the total performance guarantee.
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 8216 AIR COILS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 21 13, 23 21 16, 23 73 23, 23 81 23, 23 82 19, and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Centralized cooling and heating (pre-heat) coils are required to have an approved coil coating as identified within.
    - b) Where air coils are to be replaced as part of existing HVAC system retrofit, all accessories associated with isolation, measuring, and control of circuit (See standard de-centralized and centralized coil installation details, found in related section) shall be replaced with new and selected to match updated operating characteristics of the new air coil.
    - c) Stacked cooling coils shall be provided with intermediate condensate drain pans, and consistent with the requirements for these items, identified elsewhere in the overall Division 23 standards.
  - 2. Required:
    - a) Coatings shall be one of the following:
      - 1) PVC
      - 2) Heresite
      - 3) Electrofin



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- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. BIM information for air coil performance shall be carried within the BIM object that contains the coil.

### 3. PRODUCT REQUIREMENTS

- A. Coils:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: No preferences
  - 2. Component Characteristics:
    - a) Required:
      - 1) Use the following sizing criteria for cooling coils for buildings connected onto campus central chilled water utility:

Criteria for Centralized Air Handling Cooling Coils	System			
	Re-circulating		Greater than 50% OSA	
	VAV	CAV	VAV	CAV
Minimum Cooling Coil Depth (Rows)	8	8	10	10
Max Finned Area Coil Face Velocity	400 FPM	350 FPM	350 FPM	350 FPM
Minimum Fins Per Inch	10 FPI	10 FPI	10 FPI	10 FPI
Max Fins Per Inch	10 FPI	10 FPI	10 FPI	10 FPI
Max Air Pressure Drop	0.75"	0.75"	0.75"	0.75"
Design Inlet Water Temperature (°F)	45	45	45	45
Design Leaving Water Temperature (°F)	65	65	65	65
Max Supply Air DB Temperature <u>Leaving Air Handler</u> (°F)	55*	55*	55*	55*
1. * Adjust <u>leaving coil</u> temperature based upon blow-thru vs. draw-thru coil configuration. 2. * Refer to Section 23 0000 for appropriate temperature based upon project requirements.				

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Criteria for Centralized Air	System			
Minimum Water Pressure Drop at 20°F Temperature Differential	7'	7'	7'	7'
Max Water Pressure Drop at 20°F Temperature Differential	10'	10'	10'	10'
Fin Material and Coating	See 23 7323	See 23 7323	See 23 7323	See 23 7323

- 2) For sizing criteria related to de-centralized equipment, refer to the equipment section's stated criteria.
- 3) Use the following sizing criteria for heating coils:

Criteria for Heating Coils	Decentralized	Centralized
Minimum Heating Coil Depth (Rows)	2	2
Max Finned Area Coil Face Velocity	700 FPM	700 FPM
Minimum Fins Per Inch	8 FPI	8 FPI
Max Fins Per Inch	12 FPI	12 FPI
Fin Material	Aluminum fins, copper tubes, stainless steel casings.	See 23 7223

- b) Preferred:
  - 1) Coil circuiting will typically provide the desired conditions for coil performance.
- c) Disallowed: None

#### 4. INSTALLATION REQUIREMENTS

- A. Required:
  1. Refer to Section 23 21 13 for cooling and heating coil connection details.
  2. Provide hydronic piping supply and return temperature sensors connected to the BMS at coil connections. Where supply and return temperature sensors exist at either the building connection from the campus loop or at the building cooling or heating system, only a temperature sensor on the return piping from the coil needs to be provided.
  3. Shall be installed and piped in such a manner so local air vent is the primary (and only) high point in the branch piping circuit, between upstream main and coil.
  4. Isolation valves, strainers (or approved valve kits containing any one of these items), to be installed in horizontal segment of branch piping associated with individual air coil.
  5. Braided flexible connections at final connection to air coil. Associated piping and coil shall be installed and supported as to not impart load on flexible connections. Flexible connection length shall not exceed 12 inches.

- B. Preferred:
  1. None.

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- C. Disallowed:
  - 1. Braided flexible connections other than at final connection to air coil.
  - 2. Dielectric flanges at copper cooling coil piping transitions to steel piping for piping 2" or less in size. Refer to section 23 2113.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Coils.
- B. Documentation required:
  - 1. Test reports: Testing, Adjusting and Balancing.
  - 2. Commissioning report.
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 8219 FAN COIL UNITS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 13 4800, 23 2113, 23 2116, 23 3113, 23 4000, 23 8216, and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Refer to the following table for fan coil unit design criteria:

Fan Coil Unit Size	Design Criteria	Comments
≤ 2000 cfm	1. 45°F inlet water temperature 2. Maximum airside face velocity of 500 fpm at high speed.	Maximize water delta T with a minimum of 12°F temperature difference.
> 2000 cfm / < 5000 cfm	Refer to Section 23 82 16 for starting criteria  <i>Note: Appropriate exceptions will be considered for this application, including Semi-custom solutions.</i>	Use air handling unit cooling coil design criteria from 23 73 23 for starting criteria  <i>Note: Appropriate exceptions will be considered for this application, including Semi-custom solutions.</i>
≥ 5000 cfm	Refer to Section 23 82 16 for criteria.	Use air handling unit Cooling coil design criteria from 23 73 23.

- b) Design cooling leaving air temperature shall be 55°F from unit.

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- c) Clearly identify the service area required by the selected fan coil unit within the floor plan layout. Utilized dashed lines to indicate required service area and coordinate fan coil placement with existing utilities and fixed furniture/equipment. Ensure that indicated location will allow required accessible service.
- d) The fan coil shall meet all cooling and heating loads at the design criteria operating at medium fan speed setting as maximum. If the unit only has low and high fan speed options, select coils based on low fan speed airflow.

### 2. Disallowed:

- a) Fan Motors shall not be selected in the service factor.
- b) VFD shall not be selected to operate above 60Hz.
- c) Layout and positioning of fan coil units above lab equipment, or fixed furniture, that prohibits needed servicing.
- d) Use of leak detection sensors for automatic shut off for secondary drain.

### B. BIM requirement:

- 1. The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Fan coil units shall have a BIM family provided within the BIM model, inclusive of motors, coil and filter information.

## 3. PRODUCT REQUIREMENTS

### A. Fan Coil Units:

#### 1. Manufacturers:

- a) Required: Fan coil units that are to be specified for use within OSHPD approved projects shall have Special Seismic Certification Pre-Approval (OSP).
- b) Preferred:
  - 1) Airtherm
  - 2) USA Coil & Air
  - 3) Enviro Tec
  - 4) First Co.
  - 5) Daikin
  - 6) Trane
  - 7) Carrier

#### 2. Component Characteristics:

- a) Required:
  - 1) Blow-thru type with coil located downstream of the fan to trap fan heat.
  - 2) Direct drive fans if offered as a standard product size.
  - 3) Refer to Section 23 82 16 and table on previous page for cooling coil requirements.

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- 4) Hardwired controller (thermostat) by fan coil unit manufacturer shall be provided unless otherwise noted.
  - 5) Coordinate with FPM Facilities to determine if a secondary temperature sensor connected to the Honeywell EBI is required for monitoring purposes.
  - 6) Provide MERV 13 throwaway filters upstream of cooling and heating coils per CAL-Green requirements.
  - 7) The engineer needs to prove that gravity flow is not possible before he specifies use of a condensate drain pump. Condensate drain discharge should terminate in same room (CPC).
  - 8) Provide stainless steel primary drain pans.
  - 9) Provide galvanized steel secondary drain pans. Secondary drain pans shall extend beneath the unit as well as the coil connections. A sloped drainpipe connected to the secondary drain pan routed to spill to a visible location (above doorway) or as approved.
- b) Preferred:
- 1) Use direct drive for nominal CFM selections up to 1200 CFM (3 tons). Provide direct drive fan coil units whenever project manufacturer has direct drive fan coils in larger selections.

## 4. INSTALLATION REQUIREMENTS

### A. Required:

1. Provide hydronic piping supply and return temperature sensors connected to the BMS at the fan coil unit coil connections. Where supply and return temperature sensors exist at either the building connection from the campus loop or at the building cooling or heating system, only a temperature sensor on the return piping from the fan coil unit coil needs to be provided.
2. Install fan coil units in accessible areas (such as T-bar ceiling grid). If a fan coil is to be located over hard gypsum ceiling, provide a minimum 24" x 24" access panel. Access panel shall not require special tools unless otherwise noted. Coordinate location of access panel(s) with the Architect.
3. Provide access panels positioned to allow access to and removal of all motors, fans, filters, and controls.
4. Primary condensate drain piping located within building (plenum, conditioned space) shall be insulated. Refer to Section 23 07 19 for insulation requirements.
5. Where bottom access required for maintenance, secondary drain pan and associated piping shall be installed so to be easily demountable for service.
6. Temporary filtration for units, through construction and startup, shall be accounted for and provided for both new and retrofit installations.
7. Extend secondary condensate drain pans beneath hydronic control valves and associated trim, when the fan coil unit is located within a room housing electrical or electronic equipment.
8. For none OSHPD projects, fan coil unit shall be provided with spring isolators.

### B. Preferred: No preferences

## 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Fan Coil Units.

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- B. Documentation required:
  - 1. Test reports: Testing, Adjusting, and Balancing.
  - 2. Commissioning report.
  - 3. UL listing: Fan Coil Units.
  
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 8413 HUMIDIFIERS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 22 13 and independent controls guidelines.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Do not use humidifiers except where specifically required to meet narrow relative humidity space conditions as dictated by proposed space function.
    - b) Humidifiers are to utilize softened water or RO/DI water unless specifically requested otherwise. Coordinate source requirements with Plumbing scope.
  - 2. Preferred:
    - a) Provide humidity sensor in return duct if serving multiple spaces, otherwise provide for multiple space sensors that can be polled for overall control.
    - b) Provide humidification in the main supply duct or within air handling units.
  - 3. Disallowed:
    - a) Individual space humidifiers are not allowed unless it is not practical to provide central humidification systems.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required
- C. BIM requirement: The University requires manufacturers to provide BIM family objects for final as-built documentation of all equipment requiring service and/or containing motors. Humidifiers shall have their BIM information integrated into the object containing the humidifier.

### 3. PRODUCT REQUIREMENTS

- A. Humidifiers:
  - 1. Manufacturers:
    - a) Required: No requirements



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- b) Preferred:
  - 1) Armstrong
  - 2) DriSteem
  - 3) Approved equal
- 2. Component Characteristics:
  - a) Required:
    - 1) Provide a controlling high limit humidity sensor in supply duct to override the signal to the humidifier valve and limit supply air humidity at its duct location to a maximum of 80% RH. Locate a high humidity switch in the event the supply air humidity exceeds 90% RH.
    - 2) Provide a PRV with shut-off valve and unions at the supply water line to the humidifier where pressure is  $\geq 60$  psig.
  - b) Preferred: No preferences

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Follow manufacturer's recommendation regarding minimum upstream and downstream installation dimensions (from dispersion tubes) and measures to be taken, in order to assure wetting will not occur.
  - 2. Provide access doors upstream and downstream of humidifier dispersion tubes. Refer to Section 23 33 00 for requirements.
  - 3. Steam and condensate piping:
    - a) Softened water applications: Steam piping & condensate piping shall be Rigid Copper (Type K) tubing.
    - b) R.O./D.I. water "Clean Steam" applications: Steam piping & condensate piping shall be ASTM A312 TP 304 Schedule 40 seamless stainless steel tubing.
    - c) Steam piping shall be insulated. Refer to Section 23 07 19 for insulation requirements.
  - 4. Provide plexiglass viewports in AHU/ductwork at humidifier dispersion tubes to allow observation of operation.
- B. Preferred:
  - 1. Provide stainless steel pan underneath humidifier equipment, where found above ceiling. Pan dimensions to extend to the capture to total upstream and downstream length of stainless steel ductwork.
  - 2. As applicable, provide a minimum of 3 feet of stainless steel ductwork downstream, and a minimum of 2 feet of stainless steel ductwork upstream of dispersion tubes.
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: Humidifiers
- B. Documentation required:
  - 1. Test reports: Testing, Adjusting, and Balancing.

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2. Commissioning report.
  3. UL listing: any electric equipment associated with the humidifier.
- C. Required testing protocols beyond normal Commissioning and TAB protocols: None

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 23 9000 LEAK DETECTION

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. For purpose of this guideline, this section pertains to leak detection.
  - 2. New hydronic based HVAC equipment (i.e., fan coil units, air handlers...) installed within mechanical rooms as part of a project with a total construction cost exceeding \$100,000 shall include room leak detection as part of the project. Room leak detectors shall interface with the Honeywell BMS system. A maximum of one leak detector per 500 sq. ft. of floor area may be considered for the initial design. Final quantity and placement of leak detectors shall be coordinated with FPM during design development, based on room and piping layout.
  - 3. Provide room signage indicating that a wet floor monitoring system is in place. Notify the FPM customer resource center if the sensors are to be wet during maintenance or repair work.
- B. Quality Assurance requirements beyond standard 1 year warranty: None
- C. Coordinate with Honeywell Controls.

### 3. PRODUCT REQUIREMENTS

- A. Water Leak Detector:
  - 1. Manufacturers:
    - a) Required: N/A
    - b) Preferred: Building Automation Products, Inc (BAPI), Kele Mfr, or approved equal.
    - c) Disallowed: All others.
  - 2. Component Characteristics (Required):
    - a) Water leak detector transmitter with contacts. Rope, or tape, sensor length as determined by project requirements.
    - b) Part Numbers:  
BAPI: E24, LDTx-RRxx-BB-LTF  
Kele: WD-2-T.

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### **4. INSTALLATION REQUIREMENTS**

- A. Confirm Honeywell controller is installed in location. If none existing, provide a new controller with data interface. See controls standards.
- B. Provide control wires from water detection system to Honeywell controller.

### **5. EVALUATION or COMMISSIONING**

- A. Confirm communication between water detection system and Honeywell controller.
- B. Confirm communication between water detection system and BMS.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 25 0000 INTEGRATED AUTOMATION

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to all product based sections.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

- D. Additional Information:
  - 1. The engineer shall refer to the USC HVAC Controls Master Specification for the development of the Division 25 Integrated Automation specifications. The guideline can be found at the following location:  
[http://facilities.usc.edu/uploads/documents/outline\\_specifications/EMCS\\_Specifications.pdf](http://facilities.usc.edu/uploads/documents/outline_specifications/EMCS_Specifications.pdf)

### 2. PROCEDURAL REQUIREMENTS

- A. Refer to the above referenced guideline for specific requirements.

### 3. PRODUCT REQUIREMENTS

- A. Refer to the above referenced guideline for specific requirements.

### 4. INSTALLATION REQUIREMENTS

- A. Refer to the above referenced guideline for specific requirements

### 5. EVALUATION or COMMISSIONING

- A. Refer to the above referenced guideline for specific requirements.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 0000 ELECTRICAL DESIGN REQUIREMENTS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to all product-based sections. For exterior enclosure requirements, refer to 01 8316
- C. Utilization Voltages

#### **UPC – University Park Campus:**

##### Primary Voltages:

4.8kV, 3 Phase, 3 Wire

##### Secondary Voltages:

Normal

480Y/277V, 3 Phase, 4 Wire  
208Y/120V, 3 Phase, 4 Wire

Emergency/Standby

480Y/277V, 3 Phase, 4 Wire  
208Y/120V, 3 Phase, 4 Wire

##### Branch Circuits:

General Use Receptacles

120V

Special Purpose Receptacles

208V, 1 phase and 208V, 3 phase

Lighting

277V

Special Purpose Lighting

120V

Motors 1/3 HP and smaller

120V

Motors 1/2 HP and larger

480V, 3 phase

##### Existing Voltages:

Secondary – Normal

240/120, 1 Phase

#### **HSC – Health Sciences Campus:**

##### Primary Voltages:

12.47kV, 3 Phase, 3 Wire

##### Secondary Voltages:

Normal

480Y/277V, 3 Phase, 4 Wire  
208Y/120V, 3 Phase, 4 Wire

Emergency/Standby

480Y/277V, 3 Phase, 4 Wire  
208Y/120V, 3 Phase, 4 Wire

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### Branch Circuits:

General Use Receptacles	120V
Special Purpose Receptacles	208V, 1 phase and 208V, 3 phase
Lighting	277V
Special Purpose Lighting	120V
Motors 1/3 HP and smaller	120V
Motors 1/2 HP and larger	480V, 3 phase

### Existing Voltages:

Secondary – Normal	240/120, 1 Phase
--------------------	------------------

### D. Voltage Swings

1. USC gets its power from the Los Angeles Department of Water and Power (LADWP). LADWP reports as standard operating procedures, a voltage swing of +/- 5%.
2. Equipment that resides in any USC buildings need to accommodate this voltage swing or shall be provided with alternate methods of providing non-fluctuating voltage.

### E. Campus Site Utilities:

1. Primary Service Location & Coordination
  - a) University Park Campus has two primary service vaults.
  - b) Health Sciences Campus has one primary service vault serving the campus and two service vaults serving the Hospitals.
  - c) University Village has one primary service vault.
  - d) Information related to these vaults, including available fault current and feeder information is provided on a project-by-project basis by FPM Engineering.
  - e) Required information from the project team includes projected loads as well as the location of service entrance equipment.
  - f) Information related to the specific feeder(s) to be connected to, manhole(s) to be connected to, available fault current(s) and related information will be provided by FPM Engineering.
2. Electrical Metering
  - a) Metering System: The standard metering system is the Eaton Power Monitoring System. Eaton meters are the only accepted meters.
  - b) Meters must meet requirements of Section 26 2713 Electricity Metering.
  - c) Meters shall be provided to meet all code requirements, shall be included on the main distribution board, any sub-distribution boards as required by FPM Facilities, for any event power provided, and on the load side of all automatic transfer switches (ATS).
3. Primary Feeder Equipment and Distribution Equipment

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- a) Distribution Circuit Arrangement: Both UPC and HSC are connected in a radial feeder arrangement.
- b) Manholes and Handholes
  - 1) UPC has a distribution system including 79 manholes and 18 handholes. HSC has a distribution system including 19 manholes and 2 handholes. University Village has a distribution system including 6 manholes.
  - 2) FPM Engineering will identify connection location(s) and designated manhole(s) or handhole(s) for each project. FPM Engineering will also provide details and fault current information for each manhole or handhole.
  - 3) For manhole and handhole requirements refer to Section 33 7119.
- c) Medium Voltage Feeders
  - 1) 33% spare capacity shall be included for each feeder. Conduits shall not be more than two-thirds filled.
  - 2) For every conduit provided for the project, an equal number of spare conduits shall be provided from the manhole to the Main Electrical Room. Conduits shall be a minimum of 5". Wire size shall be a maximum of 500 MCM.
- d) Medium Voltage Termination: Conductor terminations may be cold or heat shrink type termination kits rated 15kV, 95kV BIL with current rating same as the cable. Splice kits are not acceptable.
- e) Power Shut Off Notification:
  - 1) 14 day written notification is required prior to any power shut down. Written approval will be given by FPM Facilities including the approved date and time of shut down. This information is to be included in the General Notes section of the drawings, typically located on sheet E-000.
  - 2) Utility shutdowns will only be approved and scheduled after sign-off by Electrical Inspector. Electrical Contractor to provide documentation that Inspector has agreed to allow equipment to be energized.
- F. Buildings with Dual Feeds: Dual feed requirements are determined by FPM Engineering.
- G. Exterior Enclosure: Equipment located outside of the building shall have an enclosure provided around it to meet the requirements in 01 8316 Exterior Enclosure Performance Requirements.
- H. Commissioning:
  - 1. USC will engage an Independent Consultant to perform the role of a Commissioning Agent. Please refer to the independent Commissioning Guidelines for more information regarding sample Pre-Functional Checklists and Functional Test procedures.
  - 2. The Commissioning Agent will review and provide comments on the following design documents: Schematic Design, Design Development, Construction



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Documents. The design team shall provide written response and evaluation of the comments.

3. During the Design Development Review, the design team shall cooperate with the Commissioning Agent to develop criteria for test protocols to be included in the Construction Documents.
4. If items remain unresolved between the Commissioning Agent comments and the design team by the end of the Construction Documents Commissioning Review and Response, the design team shall engage with USC to resolve any remaining disagreements and reach consensus on the final content of the Documents.

## 2. PROCEDURAL REQUIREMENTS

### A. Standards and Code Requirements

1. UL Listing and Code Compliance
  - a) All equipment shall be UL listed, shall be provided with proper identification related to the UL listing, as well as appropriate listing documentation.
  - b) All equipment and electrical spaces shall meet the minimum code requirements including all LA City codes and amendments. The website for the Los Angeles Department of Building and Safety (LADBS) should be consulted as to the current codes and amendments.
2. Code References:
  - a) All drawing sets shall include code references to the specific code being applied including the California Electrical Code (CEC), National Electrical Code (NEC) and LA City Amendments. This reference shall be made on the E-000 sheet.
  - b) All drawing sets shall include code references to the specific Title 24 Energy Code being applied to project. This reference shall be made on the E-000 sheet.
  - c) General code references to the "current edition of the code" on design documents are not acceptable. The current code at permit time per LADBS shall be indicated on the design documents.
3. Calculations: Short circuit calculations shall be provided on each project. (See specification Section 26 0573 "Overcurrent Protective Device Coordination Study" for calculations and analysis)
4. If any portions of this guideline are found to conflict with one another, formal clarification shall be requested from FPM Engineering. While request is under consideration, the design team shall assume that the stricter requirement / standard of care should apply.
5. This guideline is not to be considered as a means or implied approval to violate local and state general building or trade codes.

### B. Design Criteria

1. Single Line (One-Line) Diagram Requirements:

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- a) Single line diagrams shall be of the most accurate and descriptive nature allowed by the available information. Site surveys and earlier drawings shall be used as references to ensure that the single line being depicted is as up to date as possible.
- b) Projects that include multiple story buildings, regardless if the project scope includes only one floor\*, shall have a “riser” style single line diagram. The single line shall be broken up into floors and the equipment, both existing and new, shall be shown on the appropriate floor.
- c) The basement (or lowest level of the building) shall be shown on the bottom of the sheet. The roof (or highest level of the building) shall be shown on the top of the sheet. Floor delineations shall be in the form of horizontal lines labeled with the USC recognized floor name.
- d) Projects that include single story buildings or areas may have a “flow” type single line diagram.
- e) Projects including multiple electrical rooms on one floor shall have single line diagrams that indicate the room number of each electrical room the gear is located in for quick reference.

\*Exceptions may be made by FPM Engineering in the case of smaller TI projects that do not require the installation of major pieces of equipment. In these cases, determined on a project-by-project basis, the existing single line may be used and amended as necessary.

- f) All Single Line Diagram sheets shall include the following information:
  - 1) All connected building equipment, including panels, generators, switchboards, utility equipment, mechanical gear, etc.
  - 2) Names, locations, and ratings of all gear
  - 3) Feeder schedule for equipment included in scope of work. Feeder schedules that do not fit on the single line, due to the amount of equipment being shown, shall be located on an adjacent sheet. The single line sheet shall refer to the adjacent sheet with the feeder schedule.
  - 4) Load Summary: The load summary can be in the form of panel schedules or a table. The load summary shall include all equipment loads being fed into the main switchgear.
  - 5) Scope of work: The equipment related to the scope of work of the project shall be highlighted or some other way indicated as included in the project. All building equipment shall be shown as reference and may be indicated as such.
  - 6) Sheet notes shall be provided as necessary.

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- 7) Available fault current and AIC ratings at each bus
  - g) Single Line Diagram sheet numbering:
    - 1) Single line diagrams shall be in the 700 series sheet numbers, regardless of how many sheets are in the set.
    - 2) Normal single line diagrams shall be first in the series. Emergency single line diagrams shall come next in the series.
    - 3) For smaller projects, single line diagrams may be combined with panel schedules to minimize the page usage. In such cases, the combined single line / panel schedule sheet shall still be located in the 700 series sheet numbers.
  - h) See USC General Standard Guidelines for additional information.
2. Panel and Load Summary Schedules:
- a) Panel and load summary schedules shall be in the 600 series sheet numbers. Exceptions can be made in case of smaller projects where schedules may be added to single line diagram sheet(s).
  - b) Electrical engineer of record (EEOR) is responsible to field verify existing panel schedules to ensure accurate information is reflected on plans.
  - c) Electrical engineer of record (EEOR) is responsible for electrical load capacity verification at the panel to which load is being added and upstream power source by using connected load data on existing panel/load schedules, available USC metered demand load data, or requesting demand load ammeter recording during the Schematic Design phase of the project.
  - d) Existing panel schedules missing connected load information and not matching field condition may not be used as load verification method.
  - e) Demand load ammeter recording shall be over a minimum 30-day period per CEC Article 220. A 7-day interim recording is recommended ensure adequate spare capacity is available and determine alternate power source as needed. Report shall include xls data file with the following information:
    - Number of phases, wires, frequency, logger model, last calibration date, and measuring intervals.
    - Minimum, maximum, and average values for:
      - Each phase and 3-phase Volt.
      - Each phase and 3-phase Amp.
      - Each phase and 3-phase KW.
      - Each phase and 3-phase KVA.
      - Each phase and 3-phase PF.
3. Provide, design, dimension, coordinate and install the following items:
- a) Support and anchorage of all equipment and conduit.
  - b) Fittings for seismic expansion and deflection. Refer to Section 26 05 33. "Raceway & Boxes for Electrical Systems".

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- c) Vibration isolation and seismic anchorage.
- C. Floor Plan Requirements:
- 1. Panel Schedules
    - a) All electrical drawing sets shall include panel schedules. These sheets shall include any and all panels affected by the project scope, regardless of whether the gear is directly or indirectly affected.
    - b) “Existing” and “New” condition panel schedules are preferred on drawings for existing panels. If existing condition panel schedules are not included, it the design engineer’s responsibility to clearly define each circuit/load being removed in their sheet notes.
    - c) Any panel being referenced by a home run in the floor plans shall have an individual panel schedule and a load summary.
    - d) Panel schedules shall indicate where the panel is located, especially in the cases of large projects with several Electrical Rooms.
    - e) Reference boxes should be included on each sheet in the drawing set that includes panel schedules. The reference box should indicate where on the page each panel schedule is located for quick reference.
  - 2. Luminaire Schedule: A luminaire schedule shall be provided for all projects and shall be included in the electrical drawing set. Schedule shall be in table format and shall include all the pertinent information necessary for the sub-contractor.
    - a) Luminaire identification/designation.
    - b) Description and dimensions.
    - c) Color temperature and CRI.
    - d) Wattage.
    - e) Voltage
    - f) LED type.
    - g) Finish.
    - h) Mounting (recessed, surface, suspended, etc.).
    - i) Manufacturer and model number.
    - j) Control type.
- D. Circuiting and Identification Requirements
- 1. Each home run shall indicate the corresponding panel name and the circuit number(s).
  - 2. Lighting plans and/or reflected ceiling plans shall show the respective lighting panel in its proper location in each electrical room to provide clear indication of home run destination.
- E. Special FPM Facilities criteria/requirements:
- 1. Identification: The identification of all equipment shall follow the University standard specifications Section 26 0553 “Identification of Electrical Systems”. This includes all the text to be written on the nameplate, as well as the color and location.
  - 2. Equipment Naming:
    - a) Naming Categories

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### (Emergency)

\*Only used in cases where emergency power is provided. Category omitted for Normal power.

EL-	Emergency-Life Safety (as defined by NEC Article 700)
ER-	Legally Required Stand by (as defined by NEC Article 701)
E-	Optional Stand by (as defined by NEC Article 702)

### Type

\*Panels are the default type. No specific Type is provided for panels.

U	Unit Substation
DB	Distribution Board
G	Generator
ATS	Automatic Transfer Switch
T	Transformer

### Voltage

H	480 or 480/277
L	208/120V

### (Area)

\*Only used for larger buildings. Category omitted in cases of smaller buildings.

N	North
S	South
E	East
W	West

\*Segments A, B, C, D are also acceptable.

### Floor

B	Basement
1	First
2	Second
3	Third
R	Roof
M	Mezzanine

### Alpha

A	Panel
AA	Sub panel to A

\*Alpha category is sequential. The second panel follows with B and so on.

- b) Conventions: See Naming Categories above for the selection options in each category.
- 1) Switchboards/Distribution Boards/Panels Naming Convention

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Panels shall be named based on the following criteria –

### **(Emergency-) Type Voltage (Area) Floor Alpha**

Example 1: a standard 120/208V, panel located on the south side of the first floor

**LS1A**

Example 2: a 480V emergency standby distribution board located on the north side of the basement

**E-DBHNB**

### 2) ATS Naming Convention

ATS shall be named based on the following criteria –

### **(Emergency-) A Voltage (Area) Floor (Alpha)**

Example 1: an emergency stand by 480V ATS in the basement

**E-AHB**

### 3) Transformer Naming Convention

Transformers shall be named based on the following criteria–

### **(Emergency-) T (Area) Floor (Alpha)**

Example 1: a life safety transformer in the south area of the basement

**EL-TSB**

Example 2: the first of two normal transformers on the first floor

**T1A**

- 4) Miscellaneous equipment: Other equipment, including but not limited to UPS, PDUs and RDCs, shall follow similar to the Panel Naming Convention and will use the first letter to identify the equipment.
- c) New or Renovated Buildings: For new buildings and completely renovated buildings, panels shall be named in relation to the floor the panel is located on and the type of power the panel is providing. See Conventions section above for additional information.
- d) Existing Buildings: For existing buildings, panels shall be named in coordination with existing panels. If no pattern is evident in the existing building for panel naming. See Conventions section above for additional information. Verify there is no existing panel with the same name as the new panel in existing buildings.
- e) Specialty Areas: For buildings with specialty areas, such as a vivarium, that includes dedicated equipment for that specialty area separate than the base building, naming of the dedicated equipment shall correspond to the specialty area.

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For example, a vivarium added to an existing building will add a dedicated ATS, generator, distribution board, transformer and panel. The naming convention for this equipment will include a V. Coordinate with FPM Engineering for naming convention for specialty areas.

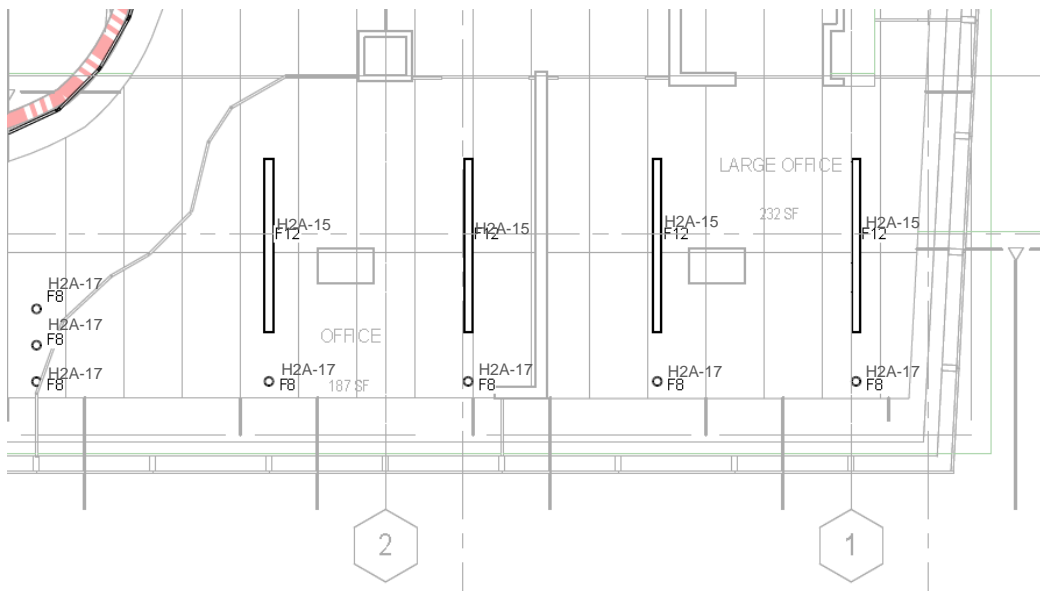
### 3. Lighting Floor Plan Fixture Labeling

On the electrical lighting floor plans and/or reflected ceiling plans, each light fixture shall have the following information:

Fixture type – in capital letters

Circuit Number – including panel and circuit

Designation for switch leg on fixture corresponding to room lighting control switch/dimming device



### 4. Coordination:

- a) Light fixtures shall be coordinated with location of equipment, especially in back of house spaces. Coordination of light locations shall not be left to the contractor or “with field conditions”.

### 5. Lighting Control Devices:

- a) All lighting control devices shall be show on the lighting floor plans.
- b) All connections (120V or greater) to/from lighting control relays (or other devices requiring 120V or greater) shall be shown on the lighting floor plans.
- c) Reference of a generic detail for 120V or greater wiring to/from lighting control devices is not acceptable.
- d) Exception: If a single small room (less than 100 square feet) with accessible ceiling tiles only has a single lighting control relay, a generic detail can be used. This exception does not apply to any ceiling type other than t-bar ceilings.
- e) Lighting control devices shall be provided for lighting alteration applications regardless of type of alternation (complete replacement or component

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replacement), quantity of light fixtures, size, and type of enclosed space. The type of control devices shall be determined per Title-24 requirements for new installation of similar use. Title-24 exemptions for lighting alterations will not be acceptable.

6. Field Verifications:
  - a) Expectations: All contractors are expected to visit the project site once initiated to confirm the existing conditions, including but not limited to project space, electrical rooms, existing panels, etc. Drawings shall accurately reflect current existing conditions.
  - b) Requests
    - 1) Requests for access to the facility and equipment shall be made through the University project manager. Requests shall include areas for access and a brief overview of the plan for the visit.
    - 2) Requests for meter data or to meter equipment shall also be made through the University project manager.
7. Calculation Requirements
  - a) Overcurrent protective device coordination study shall be performed for each project. (See specification section 26 05 73 "Overcurrent Protective Device Coordination Study" for calculations and analysis requirements.)

F.

G. Quality Assurance requirements beyond standard 1 year warranty: see specific product sections.

### 3. PRODUCT REQUIREMENTS

A. Normal Power Distribution Equipment

1. Required:
  - a) Load Interrupter Switch
    - 1) A load interrupter switch shall be provided at service entrance in lieu of a load side breaker on the primary transformer.
    - 2) The use of automatic (power) or manually operated switches will depend on the application by FPM Engineering.
    - 3) Interrupter switch shall be rated at 15kV unless otherwise directed by FPM Engineering.
  - b) Utility Transformer
    - 1) The utility transformer shall be liquid filled. Transformers shall step down from current existing primary voltage (depending on the campus) to 480V or 480V/277V.
    - 2) The preferred location of the utility transformer is inside the building, in the Main Electrical Room. Transformers may be located outside the building in certain instances. Approval by the University must be given before locating a transformer outside.
    - 3) Minimum 4" concrete pads and spill containment shall be provided to meet code requirements.



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- 4) See Section 13 4800 for acoustical Noise Control considerations with respect to Transformer Room adjacency and required sound isolations.
  - 5) Consult with USC Project Manager regarding the noise and vibration isolations requirements for Transformer Room location above interior occupied spaces.
  - 6) Leak detection shall be provided in the main electrical room with connection to the building BMS. See 23 9000 Leak Detection.
- c) Primary Feeders: All primary feeders shall consist of conduit with copper wire.
- d) Secondary Distribution Transformers: Secondary distribution transformers and all downstream transformers shall be of explosion resistant, fire-resistant, air insulated, dry type construction, cooled by the natural circulation of air through the windings. Only copper windings shall be specified.
- e) Distribution and Branch Circuit Panelboards:
- 1) Panelboards that are not located in the same room as their distribution breaker shall have a main breaker provided in the panel. Exceptions may be made for panels located on the same floor as their distribution breaker, determined on case-by-case basis.
  - 2) Ground fault protection is to be provided at the building main breaker(s) as well as on any breakers larger than 1000A, 480V only.
- f) Variable Frequency Controllers: See mechanical specification section 23 05 14 for requirements.
- g) Secondary Feeders
- 1) All secondary feeders shall consist of conduit and copper wire.
- h) Branch Circuits
- 1) Ratings and Size: Branch circuits shall be at minimum #12AWG, solid.
  - 2) Acceptable Conduit Types
    - i) Conduit shall be specified as Electrical Metallic Tubing (EMT) or Intermediate Metal Conduit (IMC).
    - ii) Flexible metal conduit (FMC/LFMC) is acceptable for up to 6-foot max for final terminations to light fixtures and vibrating equipment.
    - iii) Type AC, MC and reduced wall flexible conduits are not permitted.
  - 3) Conduit Size and Fill
    - i) A minimum of  $\frac{3}{4}$ " conduit shall be specified for interior applications and 1" minimum for exterior applications. A minimum of  $\frac{1}{2}$ " conduit is acceptable for distribution to receptacles from the j-box within a space.
    - ii) No more than 6 current-carrying conductors (3-hot and 3 neutral) shall be installed in a common conduit.

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- iii) In cases where a panel is located in the same room as the corresponding circuits, exception may be made to the above requirements (typically labs).
- 4) Usage
- i) Branch circuits shall be comprised of like usage. Branch circuits with computer equipment shall have only computers on the circuit. Printers and computers shall not be placed on the same circuit. In general, motors and computers shall not be placed on the same circuit. Branch circuits with computers on them should be limited to maximum (4) computers per circuit.
  - ii) Other branch circuits shall have a maximum of 6-8 receptacles per circuit to allow for future receptacles.
  - iii) Receptacles (and light fixtures) shall be circuited such that the room or area has a diversity of circuits. For example, all outlets in one office shall not be on the same circuit. The failure of one circuit should not take down an entire area.
  - iv) Corridor outlets shall be on a separate circuit with only other corridor outlets.
- 5) J-boxes for Branch Circuits
- i) At least one j-box shall be provided for the receptacle branch circuits feeding each room. Branch circuits shall enter the room, connect to the j-box and then continue to the appropriate receptacles. If the circuit continues to an adjacent room, the connection shall be j-box to j-box.
- i) Wiring Devices
- 1) Plate Colors and Labeling
    - i) The preferred device plate is plastic. Plate colors typically are specified by the Architect. White shall be the default color. For receptacles with special power requirements, plate colors shall match receptacle colors.
    - ii) All device plates shall be labeled with originating panel and circuit numbers. The preferred labeling method is black lettering on clear ½" labeling tape.
    - iii) Projects that include pre-wired workstations are also required to have each receptacle labeled with panel and circuit number. A note shall indicate as such on both the electrical drawings as well as the furniture plans.
  - 2) Receptacle Colors
    - i) For non-switched normal power outlets, the default receptacle color shall be white.
    - ii) For switched normal power outlets, receptacle shall be green. Plate color can be standard white or green.
    - iii) For emergency receptacles, receptacle and plate shall be red.
    - iv) For UPS receptacles, receptacle and plate shall be orange.
    - v) For receptacles with isolated ground, receptacle shall be white with an orange triangle. No preference on plate color.

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- 3) Receptacle Orientation
    - i) All receptacles shall be orientated with the ground up.
    - ii) For receptacles located in wiremold, receptacle orientation shall be specified by the engineer on the documents. All receptacles included in the wiremold shall face the same direction.
  - 4) Receptacle Switching
    - i) For switched normal power outlets, entire receptacle shall be switched. Half switched outlets are not acceptable.
  - 5) GFCI
    - i) Along with code required locations, all Janitors Closets shall be provided with GFCI outlets.
- j) Housekeeping Pads
- 1) Concrete pads shall be provided for all equipment that sits on the ground located in the basement and all areas with the potential for water accumulation.
  - 2) Concrete pads shall be a minimum of 4".
2. Preferred:
- a) Panelboards are preferred to have progressive or continuous hinges with door-in-door construction.
  - b) The preferred location of the utility transformer is inside the building, in the Main Electrical Room. Transformers may be located outside the building in certain instances. Approval by the University must be given before locating a transformer outside.
3. Disallowed:
- a) Secondary Unit Substations consisting of coordinated incoming line, transformer and low voltage sections, are not preferred but may be accepted on a project-by-project basis by FPM Engineering. Secondary Unit Substations may be provided and located either outside the building or inside the Main Electrical Room. Location of the equipment is based upon the location of the building and surroundings. Equipment located outside of the building must be approved by the University architect.
  - b) Bus duct is not acceptable for any applications at the University.
  - c) Aluminum wire is not acceptable for any applications at the University.
  - d) Aluminum bus bar is not acceptable.
  - e) Aluminum transformer windings are not acceptable.
  - f) Feed through panels are not acceptable for new construction. For existing conditions that have feed through panels, load may be added but additional feed through panels should not be included.
  - g) Aluminum conduit is not acceptable under any circumstances.
  - h) The use of non-metallic sheathed cable (NM or NMC), armored cable (AC) or metal clad cable (MC) is not permitted.
  - i) Wires shall not change colors between the breaker and the final termination.
  - j) Engraved device plates are not preferred.

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- B. Emergency and Standby Power and Lighting Systems Criteria
1. Required:
    - a) Terminology
      - 1) At USC, the term “emergency system” refers to the entire system supported by a generator.
      - 2) The Emergency System, as defined by Article 700, is more commonly referred to as the Life Safety System.
      - 3) The Legally Required Standby Systems (Article 701) and the Optional Standby Systems (Article 702) are more commonly referred to as the Standby System.
      - 4) The Essential Electrical System, as defined by Article 517, is more commonly referred to as the Life Safety, Critical and Equipment Branches in healthcare facilities.
      - 5) Regardless of terminology, all code requirements for the generator systems are to be met.
    - b) Acceptable Power Sources
      - 1) Order of Preference for Sources
        - i) The preferred method of providing emergency (life safety) power to a building is via diesel generator.
        - ii) In cases where it is not physically feasible to include a generator, a central inverter type battery system is acceptable.
        - iii) In cases where a central inverter type battery system is not feasible, individual local batteries will be permitted.
        - iv) For projects in existing buildings, the method being employed in the building shall be followed unless otherwise directed by FPM Engineering.
        - v) For OSHPD 1, 2 and 5 buildings, generator must be provided.
      - 2) Generators
        - i) For existing buildings, where a life safety generator is available, all code required life safety devices shall be dual fed by the generator.
        - ii) Generator Distribution Board: In the cases where one generator feeds multiple transfer switches, a distribution board with circuit breakers shall be provided.
        - iii) Generator Fuel Storage Requirements
          - Fuel for all generators shall be diesel fuel located either in a belly tank or local tank. Fuel tanks shall be able to sustain full load for a minimum of 8 hours. Lab buildings shall have a minimum of 24-hour fuel capacity at full load. OSHPD 1, 2 and 5 buildings shall have a minimum of 96 hours.
          - Where a fuel tank is located in-doors or in confined spaces, a remote fill apparatus shall be provided. The remote fill location should be coordinated with FPM Engineering. Where the remote fill is located outside, tamper resistant and vandalism resistant devices shall be provided.
          - Where fuel storage devices are specified with annunciator panels, annunciator panel shall interface with the University BMS System for status and alarms.

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- iv) Generator Communication: All generators, regardless of the usage, shall communicate with the University BMS EBI System. Specifications shall be per Section 26 0913 Electrical Power Monitoring and Control.
- 3) Automatic Transfer Switches
  - i) Automatic transfer switches shall be provided for the connection of generators. At least two ATS shall be provided to support both emergency (life safety) and standby loads.
  - ii) One ATS may be provided if only emergency (life safety) load is to be supported as determined by FPM Engineering.
  - iii) ATS Communication: All ATS', regardless of the usage, shall communicate with the University BMS EBI System. Specifications shall be per Section 26 0913 Electrical Power Monitoring and Control.
  - iv) Metering: Each ATS shall be metered on the load side at the respective distribution board. Meter type and connection shall be per section 26 2713 Electricity Metering.
- 4) Battery Backup
  - i) Battery backup for life safety lights and exit signs may be acceptable in instances where a generator is not available or not feasible.
  - ii) Central inverter systems with battery backup shall be provided when a generator system is not feasible. Batteries shall provide a minimum of 90 minutes per code. An automatic battery charging means shall be provided per code. See Section 26 3323 Central Battery Equipment.
  - iii) Individual battery systems shall be a last resort.
- 5) UPS Systems used at the University consist of two types. One type is the large scale, multi-module type that requires separate space and large-scale battery systems. The second type is the small, local, under the desk type or "shoe box" UPS. This section covers only the large, central type, UPS systems.
  - i) Acceptable UPS Configurations: UPS systems shall include a UPS module comprised of solid-state electronics consisting of a rectifier, an inverter and associated controls. UPS systems may be either the non-redundant or parallel redundant configurations depending on the application.
  - ii) UPS Batteries
    - Batteries for the UPS system are typically valve regulated lead acid (VRLA) batteries due to space constraints. Batteries shall provide a minimum of 30 minutes at full UPS load.
    - Each UPS module shall be provided with the necessary battery strings for that module. If more than one module is provided, each shall have its own battery strings to maintain for a minimum of 30 minutes, regardless of the other module(s).

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- iii) Maintenance By-pass Provisions: Each module shall be specified with individual maintenance by-pass provisions to allow for maximum maintainability of the system.
  - iv) Distribution: Distribution for large scale UPS systems are typically provided via power distribution units (PDU) and remote distribution cabinets (RDC). Different manufacturers have different names for these units. PDUs and RDCs models with branch circuit monitoring is preferred, where available.
  - v) Typical Manufacturers: Large UPS system manufacturers include Emerson Liebert and Powerware.
  - vi) UPS Communications: Regardless of the usage, UPS shall communicate with the University BMS EBI System. Specifications shall be per section 26 09 13 Electrical Power Monitoring and Control.
- c) Systems on Generator Power
- 1) Required Systems: All required systems shall be provided emergency power (whether life safety, legally required standby or optional standby power) to meet code requirements.
  - 2) Other Systems: The following systems shall be provided generator power on the proper code branch where available.
    - i) All access control and/or security devices shall be provided with emergency power.
    - ii) All building management system (BMS) devices shall be provided with emergency power.
    - iii) Elevator(s) shall be provided with generator power as per code requirements.
    - iv) At least (1) emergency outlet shall be provided in each electrical room, mechanical room, elevator machine room and other machine rooms.
    - v) At least (1) emergency light fixture shall be provided in each electrical room, mechanical room, elevator machine room and other machine rooms.
- d) Roll Up Generators
- 1) General Provisions
    - i) Where the building conditions require roll up generator provisions, as designated by the project or FPM Engineering, the following shall be met.
    - ii) An adequately sized breaker, meant to accommodate the critical loads in a building, shall be provided within the main switchgear. A separate section with key interlocks can be provided, or a remote disconnect can be provided to allow for the safe and efficient connections of a temporary generator. Options on where the breaker is located and how connections are made will be determined on a project-by-project basis by FPM Engineering.  
(See specification Section 26 2413 "Switchboards" for Generator Quick Connect Switchboard requirements.)
  - 2) Building Conditions
    - i) For New Buildings - Without a Generator

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- For a new building, where a permanent generator has not been specified, roll up generator provisions shall be provided.
- ii) For New Buildings - With a Life Safety Generator
  - For a new building, where a permanent life safety emergency generator has been specified, roll up generator provisions shall be provided.
- iii) For New Buildings - With a Life Safety & Standby Generator
  - For a new building, where a permanent generator has been provided for both life safety power and standby power which meets the needs of the building's Emergency Response Plan, roll up generator provisions are not required.
  - For a new building, where a permanent generator has been provided for both life safety power and standby power which either does not meet the needs of the building's Emergency Response Plan or as designated by FPM Engineering, roll up generator provisions will be required.
- iv) For Existing Buildings - Adding a Life Safety Generator
  - For an existing building, where a project involves the addition of a life safety emergency generator, roll up generator provisions should be considered. In buildings where provisions can be included without major modifications to existing switchgear and excessive cost to the project, roll up provisions shall be provided. All other buildings shall be reviewed on a case by case basis.
- v) For Existing Buildings - Adding a Standby Generator
  - For an existing building, where a project involves the addition of a stand by generator in addition to a life safety generator or to replace an existing generator, roll up provisions are not required.
- e) Fire Systems
  - 1) Fire Pump
    - i) Concrete encased cable or MI cable is acceptable for feeding the fire pump.
    - ii) When the fire pump is provided with generator power, a separate ATS shall be specified as per code.
  - 2) Fire Alarm
    - i) All fire alarm devices shall be provided with copper stranded wire, maximum size #12AWG. All wiring for fire alarm devices shall be in conduit.
    - ii) Power supplies for strobes shall be installed in maintenance spaces, preferably in the electrical rooms.
  - 3) Fire Plans
    - iii) Devices powered with 120V (or greater) shall be shown on electrical power floor plans with circuit designations for coordination.
    - iv) Fire alarm devices shall be shown on dedicated Fire Alarm plan and shall not be mixed with power plans.

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2. Preferred:
    - a) The preferred method of providing emergency (life safety) power to a building is via generator.
    - b) The preferred location of generator fuel storage is in a belly tank. Above ground tanks are also acceptable as approved by Facility Management Services.
  3. Disallowed:
    - a) Buried generator fuel tanks are not acceptable.
- C. Lighting System Criteria
1. Lighting System Overview
    - a) New buildings shall have lighting provided at 277V. Light fixtures specified for new buildings shall take into account cost, accessibility, ease of maintenance and availability of replacement parts. Specialty fixtures should be kept to a minimum.
    - b) New buildings shall be designed using LED fixtures. Existing buildings shall be retrofitted with LED fixtures where applicable.
    - c) Existing buildings may have lighting provided at either 120V or 277V depending on the age of the facility. Light fixtures specified for existing buildings shall match the existing look and feel of the building. New fixtures being specified should also consider cost, accessibility, ease of maintenance and availability of replacement parts.
  2. Normal Lighting Distribution Equipment
    - a) Branch Circuits
      - 1) Branch circuits shall be at minimum #12AWG.
      - 2) Acceptable Conduit Types
        - Conduit shall be specified as Electrical Metallic Tubing (EMT) or Intermediate Metal Conduit (IMC).
        - Flexible metal conduit (FMC) is acceptable for up to 6-foot max for final terminations to light fixtures.
      - 3) Conduit Size and Fill
        - A minimum of  $\frac{3}{4}$ " conduit shall be specified.
        - No more than 7 conductors (3-phase, 3 neutral and 1 ground) shall be installed in a common conduit.
        - 20% spare capacity shall be left on each circuit for future lights.
      - 4) Usage: Light fixtures should be circuited such that the room or area has a diversity of circuits where feasible. It is preferred that all lights in one office not be on the same circuit where multiple circuits exist in the area in order to minimize the failure of one circuit taking down an entire area.
    - b) J-boxes for Branch Circuits: At least one j-box shall be provided for the lighting branch circuits feeding each room. Branch circuits shall enter the room, connect to the j-box and then continue to the appropriate light fixtures. If the circuit continues to an adjacent room, the connection shall be j-box to j-box. Fixture to fixture connection is not acceptable.



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- c) Fixture Specifics – new and replacement LED fixtures
    - 1) LED fixtures shall meet the requirements in Section 26 5000 Lighting
  - d) Exit Signs: Exit signs shall be edge-lit LED fixtures with green lettering. In existing buildings, exit signs may be specified to match existing. Coordinate with FPM Facilities.
  - e) Lighting Control System
    - 1) Network lighting control system shall be the nLight system by Acuity Brands. See Specification 26 0943 Network Lighting Controls
    - 2) Local lighting control systems can be by nLight or approved equal, submitted by the design team, and approved by FPM Facilities.
  - f) Lighting for Pits
    - 1) Lighting shall be provided for all steam, sump, etc, pits that are included in a project.
    - 2) Provide on emergency power where applicable.
    - 3) Specify wet location fixtures only.
3. Preferred:
- a) The preferred lighting control system is nLight.
4. Disallowed:
- a) Wires shall not change colors between the breaker and the final termination.
  - b) Lightolier Dimming is not acceptable.
- D. Electrical Room Design
- 1. Main Electrical Room
    - a) Main Service Equipment located inside a building shall be within a space designated as the Main Electrical Room. The Main Electrical Room will have at least two points of exit, with a double door on a minimum of one opening. The Main Electrical Room shall have direct access to the corridor(s). All doors shall swing in the path of egress. See Section 13 48 00 for the acoustical considerations including the partition walls sound insulation ratings.
    - b) Within the design of the Main Electrical Room, consideration shall be taken to maintain proper clearances of all equipment for maintenance. The minimum clearance for most equipment shall be 4' in front. Equipment containing heavy maintenance parts shall be provided with additional clearance.
    - c) Electrical rooms shall be sized to include 20% usable space to allow addition of future electrical equipment.
    - d) Along with the design of the Main Electrical Room, the engineer shall provide the path for which to remove and replace large equipment. All equipment, regardless of size and lifespan, shall be assumed to require replacement at least once in the life of the building.
    - e) The engineer shall ensure that the Main Electrical Room is provided with ventilation and/or air condition as required to ensure proper operation of the most heat sensitive piece of equipment.

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- f) The Main Electrical Room shall be designed in an area with no Kitchen, Café or any type of cooking/warming establishments, no restrooms or water closets, no waste or waste disposal rooms located above.
  - g) The Main Electrical Room shall have no water or waste pipes running through it, regardless of the height at which such pipes are located.
  - h) Leak detection shall be provided in the main electrical room, where located at or below grade. See section 23 9000 Leak Detection for information.
2. Emergency Electrical Room
- a) In specific building requirements, a separate main electrical space may be included to house only emergency (both life safety and standby) equipment. This space shall conform to the requirements of the Main Electrical Room.
3. Secondary Distribution Electrical Rooms
- a) Each floor shall be provided with a minimum of two secondary distribution electrical rooms containing 480/277V and 120/208V equipment. One electrical room may be provided per floor if centrally located and approved by FPM Engineering.
  - b) Electrical rooms shall be located a maximum of 150 feet from the furthest point of distribution.
  - c) All secondary distribution electrical rooms shall be provided as enclosed spaces. All doors shall swing in the path of egress regardless of the size or location of the room. Lockable closets or lockable fences may be acceptable in certain applications. Panels may be located outside of the electrical room, including corridors, in special applications such as laboratory spaces or retrofit projects as deemed acceptable by FPM Engineering.
  - d) Electrical rooms shall be designed to provide the minimum code required clearance for all equipment. Electrical rooms shall be sized to include 20% usable space to allow addition of future electrical equipment. Room partition walls and floor/ceiling assembly shall provide sound insulation as required by Section 13 4800.
  - e) Electrical rooms shall not be located with Kitchen or cooking areas, restrooms or waste rooms of any kind above them.
  - f) Electrical rooms shall not have waste or water piping of any kind running through it, regardless of the height at which such pipes are located.
4. All Electrical Rooms
- a) Each electrical room shall be provided with a minimum of (2) duplex receptacles on emergency power (where available). One outlet shall be located at the door. The other shall be located at the far end of the room. Location of outlets shall be coordinated with equipment layout so as not to be covered by equipment.
  - b) Lighting shall include at least (1) emergency fixture. Larger rooms shall include a minimum of (2) emergency fixtures.
  - c) Lighting for all electrical rooms shall be coordinated with the location of equipment in the room. Adequate work lighting shall be provided to the face of all equipment.
  - d) Electrical rooms shall be sized to include 20% usable space to allow addition of future electrical equipment.

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- e) Piping other than fire sprinkler and electrical room FCU are not permitted through electrical room.
5. Mechanical Rooms and Other Spaces
- a) Each mechanical room and other equipment type spaces such as elevator machine rooms, shall also be provided with a minimum of (1) emergency duplex receptacle located at the door.
  - b) Lighting shall include at least (1) emergency fixture. Larger rooms shall include a minimum of (2) emergency fixtures.
6. Disallowed:
- a) Electrical equipment shall not be located in non-designated spaces such as janitor's closets and storage rooms. Electrical equipment shall be located in designated electrical spaces deemed as such by FPM Engineering.
  - b) Electrical equipment shall not be located directly adjacent to or above of interior spaces with NC35 or lower acoustics requirement, see Section 13 48 00 for the list of interior rooms and associated NC levels.
  - c) No equipment or piping foreign to the electrical room shall pass through the electrical room. Notification shall be provided in writing to FPM Engineering during design where this condition cannot be met.
  - d) Neither the Main Electrical Room nor any electrical room shall be located in an area with a kitchen, café or any type of cooking/warming establishment, a restroom or water closet, a waste or waste disposal room located above.
  - e) Neither the Main Electrical Room nor any electrical room shall have water or waste pipes running through it, regardless of the height at which such pipes are located.

### 4. INSTALLATION DESIGN REQUIREMENTS

- A. Required:
- 1. Any connections to university utilities must have FPM Engineering approval.
  - 2. Ensure maintenance and accessibility provisions for servicing and replacement of equipment.
  - 3. Provide adequate working area around equipment for service.
  - 4. There must be permanent access to the roof if any equipment needing service is mounted on the roof.
  - 5. Where electrical equipment is located at grade level and/or in an open area accessible to the public, a fence/gate/etc. shall be provided for security and/or visibility purposes. Coordinate requirements with FPM Engineering. Refer to Section 01 8316.
- B. Preferred:
- 1. None.
- C. Disallowed:
- 1. None.

### 5. EVALUATION or COMMISSIONING

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- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items: See individual product specification sections for which items are to be commissioned or tested. Also refer to Section 26 0810 Testing of Electrical Systems
- B. Documentation required:
  - 1. See individual product specification sections for specific documentation.
  - 2. Commissioning report: The entire emergency systems, UPS systems and lighting control systems shall fall under the scope of the Commissioning process and be subject to the protocols listed in the independent Commissioning guidelines.
  - 3. Operations and Maintenance Manuals: shall be provided as required by the independent Close-out Guidelines.

**END OF DOCUMENT**

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## 26 0513 MEDIUM VOLTAGE CABLES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 "Identification for Electrical Systems".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to Medium Voltage cables.
    - b) Do not interrupt electric service to facilities occupied by University or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
      - 1) Notify FPM Facilities in writing no fewer than 21 days in advance of proposed interruption of electrical service.
      - 2) Do not proceed with interruption of electrical service without FPM Facilities written permission.
    - c) Cables shall be shipped with moisture-proof end seals on conductors. Cable seals shall be rubber or plastic caps.
    - d) Each cable reel shall be tagged with the following:
      - 1) Manufacturer, date manufactured, and reel number
      - 2) Cable size, type, and length
      - 3) Voltage Class, and tolerances
      - 4) Customer name, order number, and job name
  - 2. Preferred: None
  - 3. Disallowed: None

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- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

A. Cables:

1. Manufacturers:
  - a) Required:
    - 1) Okonite - "Okoguard-Okoseal", cable type "Uniblend"
  - b) Preferred: N/A
  - c) Disallowed: N/A
2. Component Characteristics:
  - a) Required:
    - 1) Cable Type: MV105, 15kV.
    - 2) Comply with UL 1072, AEIC CS8, ICEA S-93-639, & ICEA S-97-682.
    - 3) Conductor: Single shielded, Stranded copper conductors.
    - 4) Conductor Stranding: Concentric lay, Class B, compact stranded.
    - 5) Strand Filling: Conductor interstices are filled with impermeable compound.
    - 6) Conductor Insulation: 220 mils, ethylene-propylene polymer (EPR) insulation with 133% insulation level
    - 7) Shielding: Copper tape, helically applied over semiconducting insulation shield.
    - 8) Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding
    - 9) Cable Jacket: Sunlight-resistant PVC.
  - b) Preferred: None
  - c) Disallowed: Aluminum conductor.

B. Raceway Tags:

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred: Tech Products Inc.- Fast Tag Miniature Markers
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Provide tags with highly-raised characters, hot stamped with UV stable foil, non-conductive and non-corroding.
    - 2) Tags shall be black lettering on yellow background
    - 3) Attach tags to raceways with noncorrosive stainless steel wire.
    - 4) Tags shall be provided at minimum where the cable enters and leaves the manhole.
3. Labeling Verbiage
  - a) Where the cable enters the manhole
    - 1) Line 1: 'Voltage' – CKT 'X'
    - 2) Line 2: From MH 'X'
    - 3) Example:  
4800V – CKT A  
From MH 5
  - b) Where the cable leaves the manhole
    - 1) Line 1: 'Voltage' – CKT 'X'

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- 2) Line 2: To MH 'X' or 'Building'
  - 3) Example 1:  
4800V – CKT A  
To MH 200
  - 4) Example 2:  
4800V – CKT A  
To NML
- C. Cable Splicing and Terminating Products and Accessories:
1. Manufacturers:
    - a) Required: No requirement
    - b) Preferred:
      - 1) Thomas & Betts Corporation/Elastimold
      - 2) Engineered Products Company
      - 3) G&W Electric Company
      - 4) RTE Components; Cooper Power Systems, Inc.
      - 5) Scott Fetzer Co. (The); Adalet.
      - 6) 3M; Electrical Products Division
    - c) Disallowed: None
  2. Component Characteristics (Required):
    - a) Solid Terminations for Shielded-Cables: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.
      - 1) Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
      - 2) Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
      - 3) Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
      - 4) Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
      - 5) Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, coldshrink- rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
      - 6) Class 3 Terminations: Kit with stress cone and compression-type connector.
    - b) Separable Insulated Connectors:
      - 1) Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
      - 2) Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

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- 3) Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.
  - 4) Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
  - 5) Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
  - 6) Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
  - 7) Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
  - 8) Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
  - 9) Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.
- c) Arc Proofing Materials:
- 1) Tape for First Course on Metal Objects: 10-mil thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
  - 2) Arc-Proofing Tape: Fireproof tape, flexible, conformable, in tumescent to 0.3 inch thick, compatible with cable jacket.
  - 3) Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch wide.
- d) Preferred: None  
e) Disallowed: None  
f)

## 4. INSTALLATION REQUIREMENTS

- A. Required:
1. Install cables according to IEEE 576.
  2. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values
    - a) Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
    - b) Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
  3. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
  4. Install "buried-cable" warning tape 12 inches above cables.



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5. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls, one loop minimum, by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
6. Install cable splices at pull points and elsewhere as indicated; use standard kits.
7. Install terminations at ends of conductors and seal multi-conductor cable ends with standard kits.
8. Install separable insulated-connector components as follows:
  - a) Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
  - b) Portable Feed-Through Accessory: Three.
  - c) Standoff Insulator: Three.
9. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc proofing tape manufacturer's written instructions, apply arc proofing as follows:
  - a) Clean cable sheath.
  - b) Wrap metallic cable components with 10-mil pipe-wrapping tape.
  - c) Smooth surface contours with electrical insulation putty.
  - d) Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
  - e) Band arc-proofing tape with 1-inch- wide bands of half-lapped, adhesive, glass-cloth tape 2 inches o.c.
10. Terminations:
  - a) All terminations shall be accomplished via pre-molded EPDM type connection system. The 600 amp separable insulated connector system shall be rated for continuous operation at 15kV for single conductor shielded power cables and shall be non-load / dead break type.
  - b) The system shall be made up of specific kits (600 amp) designed for, tapping (adding-on) dead-ending and connecting equipment. Dead-break cable terminators shall be elbow type with 600A continuous current rating.
  - c) The system shall accommodate a 15kV cable size of 250 MCM, copper conductors. The system shall be capable of making dead-end, 2-way and multiple tap splices and shall be suitable for continuous immersion under water.
  - d) Conductor terminations may be cold or heat shrink type termination kits rated 15kV, 95kV BIL with current rating same as the cable. Splice kits are not acceptable
11. Seal around cables passing through fire-rated elements according to Division 07.
12. Install fault indicators on each phase where indicated.
13. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

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- B. Preferred: None
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Medium Voltage Cables.
- B. Documentation required:
  - 1. Test reports: The University will engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all MV Cable installations, including splices and terminations.
  - 2. Source quality report (Factory test results):
    - a) Test and inspect cables according to ICEA S-93-639 before shipping.
  - 3. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig.
- C. Required testing protocols:
  - 1. The independent testing agency shall perform the following field tests and inspections and prepare test reports:
    - a) Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.3. Certify compliance with test parameters.
    - b) After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
  - 2. Corrective measures:
    - a) Remove and replace malfunctioning units and retest as specified above.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 0519 LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 "Identification for Electrical Systems".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to Building conductors and cables and wiring connections and terminations
    - b) Furnish products listed and classified by UL, CEC, and LA City recognized/approved agency as suitable for purpose specified and indicated.
    - c) Wire and cable boxes and reels shall bear the date of manufacture. The date of manufacture shall not precede contract date by more than one year.
    - d) Conductor sizes indicated are based on copper conductors. Do not provide conductors smaller than those indicated, unless noted otherwise.
    - e) Coordination: Set sleeves in cast-in place concrete, masonry walls and other structural components as they are constructed.
  - 2. Preferred: None
  - 3. Disallowed: Wires shall not change colors between the breaker and final termination.
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Conductors and Cables:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) American Insulated Wire Corp: a Leviton Company

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- 2) General Cable Corporation
  - 3) Southwire Company
  - 4) Senator Wire & Cable Company
  - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required - Single Conductors 600V and below:
      - 1) Provide copper conductors.
      - 2) Provide stranded or solid conductors as specified in this section.
      - 3) Provide conductors with Type THHN/THWN, 90°C insulation for indoor applications.
      - 4) Provide conductors with Type THWN-2 or XHHW-2, 90°C insulation for exterior, wet or damp locations.
      - 5) Provide conductors with Type RHW-2, 90°C insulation for areas subjected to temperatures exceeding 60°C (140°F).
      - 6) Comply with NEMA WC 70.
    - b) Preferred: None
    - c) Disallowed:
      - 1) Aluminum conductors.
      - 2) MC cables.
- B. Connectors, Splices and Terminations:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) AFC Cable Systems, Inc.
      - 2) Hubbell Power Systems, Inc.
      - 3) O-Z/Gedney; EGS Electrical Group LLC.
      - 4) 3M; Electrical Products Division
      - 5) Tyco Electronics Corp
    - c) Disallowed: None
  - 2. Component Characteristics (Required):
    - a) Provide factory-fabricated connectors, splices and terminals of size, ampacity rating, material, type and class for application and service indicated.
    - b) Connections to Fixtures: Make circuit wiring connections to fixture wire with insulated electrical spring connectors. Threaded-type wire nuts, porcelain or Bakelite are not acceptable.
    - c) Wire Joints:
      - 1) No. 6 AWG and larger: Burndy Type QPR, Penn Union, or equal.
      - 2) No. 8 AWG and smaller: Pigtail splices, or made with insulated electrical spring connectors.
    - d) Preferred: None
    - e) Disallowed:
      - 1) Wago Connectors
  - 3. Terminations:
    - a) Provide compression set, bolted, or screw type lug, or direct to bolted or screw type terminal.
    - b) Connections to Circuit Breakers and Switches:
      - 1) No. 12 AWG wire: formed around binding post or screw.
      - 2) No. 10 AWG and No. 8 wire AWG: *Buchanon Termend*, or equal locking tongue lug.

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- 3) No. 6 AWG wire and larger: Burndy *Qiklug* Type QDA, Penn Union, or equal, round flange solderless lug.
  - c) Preferred: None
  - d) Disallowed: None
  - 4. Sleeves for Cables:
    - a) Steel Pipe Sleeves: [standard], Type E, Grade B, Schedule 40, galvanized steel, plain ends.
    - b) Cast-Iron Pipe Sleeves: Cast or fabricated “wall pipe”, equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
    - c) Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
    - d) Coordinate sleeve selection and application with selection and application of firestopping specified in Section 07 84 13 “Penetration Firestopping”.
    - e) Preferred: None
    - f) Disallowed: None
  - 5. Plastic Cable Ties:
    - a) Required: Nylon or approved, locking type.
    - b) Preferred: None
    - c) Disallowed: Metallic ties
- C. Sleeve Seals:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Advance Products & Systems, Inc.
      - 2) Calpico, Inc
      - 3) Metraflex Co
      - 4) Pipeline Seal and Insulator, Inc.
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
      - 1) Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
      - 2) Pressure Plates: Stainless steel. Include two for each sealing element.
      - 3) Connection bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.
    - b) Preferred: None
    - c) Disallowed: None

## 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. General:
    - a) Do not exceed cable manufacturer’s recommendations for maximum pulling tension and minimum bending radius. Where pulling compound is

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- used, use on UL listed compound compatible with the cable outer jacket and with the raceway involved.
- b) Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the NEC and UL.
  - c) Where single conductors and cables in manholes, handholes, vaults, cable trays and other indicated locations are not wrapped together by some means such as arc and fireproofing tapes, bundle throughout their exposed length all conductors entering from each conduit with nylon self-locking releasable cable ties placed at intervals not exceeding 18 inches on center.
2. Conductors 600V and Below:
- a) Provide conductor sizes indicated on Drawings.
  - b) All wiring shall be installed in conduit unless noted otherwise.
  - c) Install conductors only after:
    - 1) Building interior is enclosed and weather tight
    - 2) Mechanical work likely to damage conductors has been completed
    - 3) Raceway installation is complete and supported
  - d) Arrange wiring in cabinets, switchgear and electrical equipment neatly cut to proper length, remove surplus wire and braid and secure in an acceptable manner.
  - e) Conceal cables in finished walls, ceilings and floors, unless noted otherwise.
  - f) Pull conductors into raceway at same time. Use pulling means; including fish tape, cable, rope and basket-weave wire/cable grips that will not damage cables or raceway.
  - g) Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible. Protect exposed cables from damage.
  - h) Support cables above accessible ceiling using plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.
  - i)
  - j) Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems".
  - k) Wiring at outlets: Install conductor at each outlet, with at least 12 inches of slack.
  - l) Limit conduit fill to a maximum of 6 current-carrying conductors. No more than three branch circuits plus associated neutral and ground conductor will be allowed.
  - m) Install stranded conductors where conductors terminate in crimp type lugs. Do not place bare stranded conductors directly under screws.
  - n) Cap spare conductors and conductors not terminated with UL listed end caps.
  - o) For conductors that will be connected by others, provide at least 6 feet spare conductors in freestanding panels and at least 2 feet spare in other assemblies. Provide more spare conductors in any particular assembly where it is obvious that more conductors will be needed to reach the termination point.
3. Conductor Material Applications:
- a) Branch Circuits: Copper conductors, solid for No. 14 AWG and smaller; solid or stranded for No. 12 AWG; stranded for No. 10 AWG and larger.
  - b) Minimum conductor sizes shall be as follows:
    - 1) No. 12 AWG – branch circuits of any kind.

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- 2) No. 14 AWG – Remote control and signal systems, fire alarm systems, except for initiating or data.
- c) Branch wiring length limitations.
  - 1) 208Y/120V circuits over 100ft in length: Increase wire size on one size for each 60 ft of length. Increase conduit size as required.
  - 2) 480Y/277V circuits over 150 ft in length: Increase wire size one size for each 150 ft of length. Increase conduit size as required.
- 4. Conductor Insulations and Wiring Methods:
  - a) Service Entrance: Type THW-2 or XHHW-2, single conductors in raceway.
  - b) Feeders:
    - 1) Less than 100A: Type THHN-THWN, single conductors in raceway.
    - 2) 100A and Larger: Type THW or XHHW-2, single conductors in raceway.
    - 3) Exposed, concealed in concrete, below slabs-on-grade and underground Feeders: Type THW or XHHW-2, single conductors in raceway.
  - c) Branch Circuits:
    - 1) Exposed: Type THHN-THWN, single conductors in raceway.
    - 2) Indoors: Type THHN-THWN, single conductors in raceway:
    - 3) Concealed in Concrete, below Slabs-on-Grade and Underground: Type THWN-2, single conductors in raceway
  - d) Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh and strain relief device at terminations to suit application.
  - e) Class 1 Control Circuits: Type THHN-THWN, in raceway.
  - f) Class 2 Control Circuits: Type THHN-THWN, in raceway
- 5. Conductor Color Codings:
  - a) Smaller than No. 6 AWG: Provide all single conductors with integral insulation pigmentation of the designated colors.
  - b) No. 6 AWG and larger: Conductors may be provided with color coding by wrapping the conductor at each end and all accessible locations with vinyl tape. Wrap at least six (6) full overlapping turns of tape around the conductor covering an area of 1 ½ to 2 inches wide at a visible location.
  - c) Use the following colors as described:

<u>System</u>	<u>Conductor</u>	<u>Color</u>
All Systems	Equipment Grounding	Green
240/120 Volts 1-Phase, 3-Wire	Grounded Neutral	White
	One Hot Leg	Black
	Other Hot Leg	Red
208Y/120 Volts 3-Phase, 4-Wire	Grounded Neutral	White
	Phase A	Black
	Phase B	Red
	Phase C	Blue
480Y/277 Volts 3-Phase, 4-Wire	Grounded Neutral	Gray
	Phase A	Brown
	Phase B	Orange

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Phase C

Yellow

- d) Phase Rotation: Phase A, B and C implies the direction of positive phase rotation.
- 6. Connectors, Splices and Terminals:
  - a) Connectors:
    - 1) Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with the connectors being installed.
    - 2) Use bolt or compression-set type with application of insulating tape, pre-stretched or heat-shrinkable insulating tubing for splices and taps of No. 8 AWG conductors and larger. Install with hydraulic compression tool.
    - 3) Use pre-insulated "twist-on" connectors with integral spring for splices and taps of No. 10 AWG conductors and smaller.
    - 4) Tighten electrical connectors according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in [UL 466A-486B].
  - b) Splices:
    - 1) Splice wires and cable only in one accessible location, such as within junction boxes.
    - 2) Make splices to carry full capacity of conductors with no perceptible temperature rise.
    - 3) Make below-grade splices in manholes and handholes watertight with pre-stretched or heat-shrinkable insulating tubing, or resin-filled insulator.
    - 4) Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps and splices of No. 1 AWG conductors and larger.
    - 5) Plastic snap-on splice insulators are not allowed.
    - 6) Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
    - 7) No WAGO type splice connectors permitted.
  - c) Terminals:
    - 1) Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.
    - 2) Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.
    - 3) Train wires to eliminate fanning of strands, crimp with proper tool and die.
    - 4) Torque screw termination per manufacturer's recommended values. If manufacturer's torque values are not indicated, use those specified in [UL 466A-486B].
- 7. Cable Ties:
  - a) Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.
- 8. Fireproofing:



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- a) Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07.
  - b) Wrap together as a single cable all conductors entering from each conduit.
  - c) Follow tape manufacturer's installation instructions. Secure the arc and fireproofing tape at frequent intervals with bands of the specified glass cloth electrical tape
- B. Preferred: None
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Low Voltage Cables.
- B. Documentation required:
1. Test reports: The contractor will engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for service entrance and feeder conductors for compliance with requirements.
    - a) Test procedures used.
    - b) Test results that comply with requirements.
    - c) Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Required testing protocols:
1. The independent testing agency shall perform the following field tests and inspections and prepare test reports:
    - a) After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements
    - b) Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.3. Certify compliance with test parameters.
    - c) Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
      - 1) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
      - 2) Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      - 3) Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.
    - d) Perform insulation resistance testing of all power and control circuits below 600 volts with a 500-volt megger, applied for 1 minute.
  2. Corrective measures:

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- a) Remove and replace malfunctioning circuits/feeders and retest as specified above.

**END OF DOCUMENT**

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## 26 0526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 "Identification for Electrical Systems".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to grounding and bonding equipment, including but not limited to:
      - 1) Ground Rods
      - 2) Ground bars
      - 3) Active electrodes
      - 4) Mechanical connectors
      - 5) Compression connectors
      - 6) Exothermic connections
      - 7) Ground wells
    - b) All grounding products/materials shall be UL labeled and conform to the requirements of CEC and IEEE standards.
    - c) The entire electrical installation consisting of non-current carrying metal parts (i.e. raceways, cable trays, boards, boxes, cabinets, fixtures, switches, transformers, equipment and etc.) shall be completely and effectively grounded in accordance with all applicable codes and standards, whether or not such connections are specifically shown or specified.
    - d) Grounding electrodes: The grounding electrodes provided shall be as stated in CEC, except minimum conductor size used shall be #4/0 AWG and the minimum length of cables buried for grounding purposes shall be doubled.
    - e) The resistance values for the electrical system shall be as follows:
      - 1) Resistance from the main switchboard ground bus through the ground electrode to earth shall not exceed 5 OHMS unless otherwise noted.

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- 2) Resistance from the farthest panelboard, switchboard and etc. ground bus through the ground electrode to earth shall not exceed 20 OHMS unless otherwise noted.
  2. Preferred: None
  3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Ground Rods:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Eritech / Erico
      - 2) Blackburn / Thomas & Betts
      - 3) Galvan Industries
    - c) Disallowed: None
  2. Characteristics:
    - a) Required:
      - 1) All ground rods shall be copper clad steel with heavy uniform copper coating
      - 2) Dimensions: 10' long and minimum of 3/4" in diameter.
    - b) Preferred: None
    - c) Disallowed: None
- B. Ground Bars:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Eritech / Erico
      - 2) Copperweld
      - 3) Harger
    - c) Disallowed: None
  2. Characteristics:
    - a) Required:
      - 1) Provide rectangular annealed copper ground bars with pre-punched holes. The spacing and size of ground bar holes shall match the connection holes required for terminal lugs being furnished.
      - 2) Provide mounting kit complete with fasteners, insulators and brackets as required.
      - 3) Dimensions: Min. 1/4" Thick x 4" Wide x 24" Long or longer as required.
    - b) Preferred: None
    - c) Disallowed: None
- C. Active Electrodes:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Lyncole

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- 2) Eritech / Erico
    - c) Disallowed: None
  - 2. Characteristics:
    - a) Required:
      - 1) Active electrodes shall be provided as directed FPM Facilities for projects that have specific/stringent grounding requirements.
      - 2) Material: Hollow metallic, salt-filled, copper-tube electrode.
      - 3) Dimensions: 10' long, straight.
    - b) Preferred: None
    - c) Disallowed: None
- D. Mechanical Connectors:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Burndy / FCI
      - 2) Blackburn / Thomas & Betts
    - c) Disallowed: None
  - 2. Characteristics:
    - a) Required:
      - 1) Provide copper alloy connectors, suitable for grounding and bonding applications, in configurations required for particular installation.
      - 2) Ground Rod Clamps: Where required, grounding conductors shall be connected to ground rods or posts using U-bolt clamps. The cable connectors shall be "GAR" (for single cable) and "GD" (for two cable) series by Burndy.
      - 3) Water Pipe Clamps: Where required, grounding conductors shall be connected to water pipe using type "GAR-BU" series by Burndy.
    - b) Preferred: None
    - c) Disallowed: None
- E. Compression Connectors:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Burndy / FCI
      - 2) Blackburn / Thomas & Betts
    - c) Disallowed: None
  - 2. Characteristics:
    - a) Required:
      - 1) Provide irreversible compression copper connectors with high mechanical strength and electrical integrity.
      - 2) Terminal Lugs: Provide heavy-duty terminal lugs with inspection probe hole, extended barrel and two-hole tang for cable to ground bar terminations. The lugs shall be pre-filled with oxide inhibitor and individually sealed to prevent from moisture and contaminates prior to connection to bus bars. The lugs shall be "Hyground" series, type "YGHA" manufactured by Burndy.
      - 3) Cable to Cable connectors: Provide high strength connectors for cable to cable and cable to ground grid connections. The connectors shall be "Hyground" series products manufactured by Burndy.

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- b) Preferred: None
  - c) Disallowed: None
- F. Exothermic Connectors:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Cadweld / Erico
      - 2) Fuseweld / Thomas & Betts
    - c) Disallowed: None
  - 2. Characteristics:
    - a) Required:
      - 1) Provide all exothermic materials, accessories and tools for preparing and making permanent field connections between grounding system components as required.
    - b) Preferred: None
    - c) Disallowed: None
- G. Grounding Wells:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Jensen, catalog #N9
      - 2) Quickset, catalog # EC-17
      - 3) Associated
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Ground wells shall be precast concrete boxes equipped with cast iron covers with a cast iron frame cast into the box. The covers shall be checkered and bolt-on type.
      - 2) Exterior Dimensions: 14" Wide x19" Long x 12" deep, or larger, if necessary to obtain the required clearances for accessing the connectors.
    - b) Preferred: None
    - c) Disallowed: None

## 4. INSTALLATION REQUIREMENTS

- A. Required:
- 1. General:
    - a) The grounding and bonding systems installation shall be in accordance with CEC, IEEE 142 and 1100.
    - b) Provide wall mounted ground bars in all electrical rooms with insulated standoffs.
    - c) Provide ground rods at locations indicated on Drawings and as required. Provide additional rods as required to achieve specified resistance to ground. Provide grounding well at each rod location
    - d) Grounding wells installed outdoors shall be located in the nearest usable planting area, where not otherwise indicated on the Drawings. The wells in

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- planting areas shall be installed 2" above soil. Wells installed in non-planter areas shall be flush with the finished grade.
- e) Apply corrosion-resistant finish to all grounding and bonding products installed outdoors, damp locations and below ground, where factory applied protective coating has been damaged.
  - f) Conduit terminating in concentric, eccentric or oversized knockouts at panelboards, cabinets, gutters, etc. shall have grounding bushings and bonding jumpers installed interconnecting all such conduits.
  - g) All conduit stub-ups shall be grounded and where multiple stub-ups are made within an equipment enclosure, such as a switchboard, they shall be equipped with grounding bushings and bonded together and to the enclosure and the enclosure ground bus.
  - h) The System grounding conductors shall be insulated and a minimum of #4/0 AWG unless otherwise indicated and shall be continuous without joints or splices.
  - i) Equipment Grounding Conductor:
    - 1) The grounding electrode/equipment conductors' sizes shall meet or exceed CEC Tables.
    - 2) A separate insulated conductor (green) shall be provided within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
    - 3) A grounding conductor shall be extended from grounding bus of serving switchboard or panel to ground bus of downstream panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment/devices.
    - 4) A grounding conductor shall be provided in each flexible conduit and connected at each end via grounding bushing.
    - 5) Bare conductors shall be used where encased in concrete, in plenums, in direct contact with earth for ground rod rings.
  - j) Isolated Grounding Conductor:
    - 1) A dedicated and isolated grounding conductor shall be provided for circuits supplying equipment (i.e. MRI, electronic equipment, computers and etc.) that are susceptible to Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI).
    - 2) A dedicated and isolated ground bus shall be provided for all distribution equipment serving equipment/devices with isolated ground requirements.
    - 3) All isolated ground conductors for 120/208V distribution system shall be originating from upstream transformer grounding point (bus/lug).
    - 4) All branch circuits serving isolated ground receptacles shall include an isolated grounding conductor independent of equipment grounding conductor, which is extended from IG bus of serving panel to IG terminals of receptacle.
    - 5) Isolated ground conductors shall be insulated, green with yellow strip.
  - k) All non-electrical systems shall be bonded to grounding system, including but not limited to the following:
    - 1) Bond all metal siding not attached to grounded structure.
    - 2) Bond all reinforcing steel and metal accessories in any water feature (i.e. pool, fountain and etc.) structures, where applicable.

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- 3) Bond metal HVAC air ducts to equipment grounding conductors of associated fans, motors & heaters. Provide tinned bonding jumper across flexible duct connections to maintain ground continuity.
- 4) Bond gas piping system for the above ground portion of the run and downstream from equipment shutoff valve.
- 5) Provide bonding jumpers across expansion and deflection couplings in conduit runs, piping, pipe connections to water meters and dielectric couplings in metallic cold water piping system.
- 6) Bond to lightning protection system, where applicable.
- 7) Bonding pigtails shall be insulated copper conductor, identified green, sized per code and provided with termination screw or lug.
- l) Grounding Connectors and Connections:
  - 1) Provide mechanical connections for all connections to ground rods, posts, cable trays, conduits and water pipes.
  - 2) Provide compression connectors for cable-to-bar and cable-to-cable connections unless otherwise noted. All connections shall be torqued per manufacturer's specification. Attach lugs to bus with appropriate size cadmium bronze bolt, flat washer and Belleville washer.
  - 3) Provide exothermic welds for buried or concealed joints, cable-to-cable and cable to structural steel surfaces. Connections made outdoors shall be suitable for exposure to the elements. Connections made indoors shall use low smoke, low emissions process. All materials involved shall be from the same source to insure compatibility. Connections made with this process shall meet requirements of IEEE Standard 837 and other applicable specifications.
  - 4) All Buried or concealed joints shall be inspected and approved by the inspector and the University's Representative before concealment.
2. Power system grounding:
  - a) Provide, unless otherwise indicated, a main building reference ground bus at location in main electrical room that consists of the main building neutral bus bonded to the main building ground bus. Connect the following items using CEC sized copper grounding conductors to lugs on the main building neutral bus:
    - 1) Grounding electrode conductor from driven ground rods, concrete encased electrode and supplementary grounding electrodes.
    - 2) Bonding conductor to metallic cold water piping system.
    - 3) Bonding conductor to building structural steel.
  - b) Provide a dedicated ground bus in each electrical room connected to main building reference ground bus via 1" C with 1#4/0 AWG or as indicated on grounding riser diagram.
3. Separately derived electrical system grounding:
  - a) Ground each separately derived system per requirements in CEC as a minimum, unless greater requirements are stated elsewhere in the contract documents.
  - b) Transformers: Provide a dual rated four or six-barrel grounding lug with a 5/8", 11 threaded hole. Drill enclosure with 11/16" bit and attach lug to enclosure utilizing a torque bolt and a dragon tooth transition washer or equal. Connect the following when present:
    - 1) Grounding electrode conductor.
    - 2) Primary feeder ground.



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- 3) Secondary feeder ground.
  - 4) Main bond jumper.
  - 5) Isolated ground conductor (where applicable).
4. Telecommunication system grounding:
- a) Provide telecommunication ground bus, sized as required, wall mounted at main and each satellite telecommunication room with insulated standoffs.
  - b) Provide one #4/0 AWG in 1" conduit from the Main Telecommunication ground bus to the main building reference ground bus, unless otherwise shown.
  - c) Provide one #2 AWG in 3/4" conduit, unless otherwise shown from each Satellite Telecommunication ground bus or backboard to main telecommunication ground bus in the Main Telecommunication room.
- B. Preferred: None
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Grounding and bonding systems.
- B. Documentation required:
1. Test reports: The contractor will engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations and protective devices.
- C. Required testing protocols:
1. General Testing:
    - a) Visual and mechanical inspection:
      - 1) The testing agency shall inspect the grounding electrode and connections prior to concrete encasement, burial, or concealment.
      - 2) Check tightness and welds of all ground conductor terminations.
      - 3) Verify installation complies with the intent of the contract documents
    - b) Electrical Tests: The resistance to ground for all systems shall be measured by the "direct" method or "fall-of-potential" method.
      - 1) Perform "fall-of-potential" test per Institute of Electrical and Electronic Engineers (IEEE) Standard No. 81, Section 9.04 on the main grounding electrode or system.
      - 2) Perform the 2 point method test per IEEE No. 81, Section 9.03 to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral and derived neutral points.
      - 3) The earth electrode under test must be far enough away from the water pipe system to be outside its sphere of influence. Rule of thumb: Distance from the earth electrode system to the water pipe system should be about 10 times the radius of the electrode or grid to obtain a measurement within an accuracy of plus or minus 10%.
    - c) Obtain and record ground resistance measurements both from electrical equipment ground bus to the ground electrode and from the ground electrode to earth.

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- d) Device Testing: When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.13 as appropriate. Certify compliance with test parameters.
3. Perform ground resistance and continuity testing in accordance with IEEE 142.
4. Adjustments: Furnish and install additional bonding and add grounding electrodes as required complying with resistance limits specified under this Section of the Specification.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 0533 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Sections 26 05 53 and 33 70 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to raceways and boxes for electrical systems.
    - b) The size of the raceways for the various circuits shall be as indicated on the Drawings and not less than required by California Electrical Code (Chapter 9, Annex, Table C1, based on "THW" insulation type) for the size and number of conductors to be pulled therein. CEC requirements shall prevail where fill is not shown on Drawings.
      - 1) Minimum Raceway Size: 3/4 inch unless otherwise specified.
      - 2) Minimum Raceway Size: 1 inch for underground installation.
      - 3) Minimum Raceway Size: 5 inch for medium voltage cables.
      - 4) 1/2 inch raceway may be used for switch legs only with up to 3 wires plus ground or 1 CAT6 cable from switch to first J-box.
      - 5) Raceway size shall be increased to the next larger size where it shall be installed in slab or underground.
    - c) A separate raceway shall be installed for each homerun indicated on the Drawings
  - 2. Preferred: None
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty:

### 3. PRODUCT REQUIREMENTS

- A. Rigid Steel Conduit (RSC):
  - 1. Manufacturers:
    - a) Required: No requirements

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- b) Preferred:
    - 1) Allied Tube and Conduit
    - 2) Western
  - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide high quality prime steel, standard weight raceway, hot-dipped galvanized inside and out. Treads shall be hot-dipped galvanized after cutting.
      - 2) The wall thickness shall be uniform for the entire length with smooth and defect free interior.
      - 3) Fitting shall be zinc coated, ferrous metal and threaded type. Split or bolt-on type is not acceptable.
    - b) Preferred: None
    - c) Disallowed:
      - 1) Electro-galvanizing is not permitted.
- B. Electrical Metallic Tubing (EMT):
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Allied Tube and Conduit
      - 2) Western
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide tubing of high grade steel electrically welded with exterior protective coating of hot galvanized zinc, applied by the electro galvanized process.
      - 2) Tubing shall be dipped in a chromic acid bath to chemically form a corrosion-resistant protective coating of zinc chromate over galvanized surface.
      - 3) Interior surface shall be coated with aluminum lacquer or enamel.
      - 4) Fitting shall be steel, watertight, gland ring compression type, wrench tightened connectors and couplings. Manufactured by Appleton, O-Z Gedney, Cooper/Crouse-Hinds.
      - 5) Provide compression fittings
    - b) Preferred: Compression fittings
    - c) Disallowed:
      - 1) Die Cast and indenter type fittings
      - 2) Set screw fittings
- C. PVC COATED METAL CONDUIT:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Robroy Industries "PLASTI-Bond Red"
      - 2) Ocal Corporation "Ocal-Blue"
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:

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- 1) Provide PVC coated rigid steel conduits and fittings with a half lap, 40 mil extruded PVC jacket. The jacket shall have high tensile strength, shall be highly resistant to corrosion and shall not oxidize or deteriorate or shrink when exposed to sunlight and weather. The jacket shall be flame retardant and shall not support combustion.
  - 2) The interior of conduit and fittings shall be coated with urethane coating (two mil thickness) for protection against corrosion.
  - 3) Fittings and accessories shall be provided by the same manufacturer and installed in accordance with the manufacturer's specifications.
  - b) Preferred: None
  - c) Disallowed: None
- D. FLEXIBLE METAL CONDUIT:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) AFC
      - 2) Alflex
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Provide conduit manufactured from single strip, standard weight steel hot-dipped galvanized on all four sides prior to conduit fabrication.
      - 2) Provide die cast fittings of the type that screw into the inside of the conduit with threaded edges at 90 degrees to the fitting body to insure a force fit. Fittings shall be manufactured by AFC, O-Z Gedney, T&B and Steel City.
      - 3) General: flexible conduit and fittings shall provide positive ground continuity. Include a separate green grounding conductor in each run.
    - b) Preferred: None
    - c) Disallowed:
      - 1) Aluminum and light-weight steel conduits.
      - 2) Reduced-wall steel conduits.
      - 3) Binding screw type fittings.
- E. LIQUIDTIGHT FLEXIBLE METAL CONDUIT:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Sealtite Flexible type "UA"
      - 2) Flex-Seal type "XL"
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Provide conduit manufactured from single strip standard weight steel, hot dipped galvanized on all four sides prior to conduit fabrication and shall be provided with an extruded polyvinyl chloride cover.
      - 2) Provide malleable iron, zinc plated fittings with locknut and O-ring seal and slim diameter with small turning radius. Manufactured by O-Z Gedney-4Q series, T&B- 5200 series or Appleton Flexible Fittings-ST series.

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- 3) General: Liquidtight conduit and fittings shall provide positive ground continuity. Include a separate green grounding conductor in each run.
  - b) Preferred: None
  - c) Disallowed: None
- F. RIGID NONMETALIC CONDUIT (PVC):
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Carlon
      - 2) PW Pipe
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide heavy wall virgin polyvinyl chloride Schedule 40 conduit rated for use with 90°C conductors when installed in concrete encasement.
      - 2) Provide Schedule 80 conduit rated for use with 90°C conductors when installed direct buried.
      - 3) The PVC shall conform to (UL) requirements and listed for exposed and direct burial application.
      - 4) Fittings and cement shall be provided by the same manufacturer. All joints shall be solvent welded in accordance with the manufacturer's recommendations.
    - b) Preferred: None
    - c) Disallowed: None
- G. WIREWAYS:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Wiremold
      - 2) B-line
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide metal wireway where indicated on drawings or as required.
      - 2) The size shall be minimum 6"x6" unless otherwise noted. The finish shall be rust inhibiting primer coating with grey enamel finish.
      - 3) Outdoor units shall be raintight with screw covers and furnished with full gaskets.
      - 4) Provide with divider for power and data where required.
    - b) Preferred: None
    - c) Disallowed: None
- H. CONDUIT HANGERS:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Cooper B-Line
      - 2) Cush-A-Clamp

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- 3) Caddy
      - 4) Thomas & Betts
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Conduit shall be strapped using either conduit strap, conduit clips or conduit hangers as outlined below.
    - b) Preference:
      - 1) Two hole stainless steel conduit strap mounted on strut is preferred.
      - 2) Conduit clip mounted on strut may also be accepted.
      - 3) Conduit hangers, stainless steel, may also be accepted.
    - c) Disallow:
      - 1) Cable ties, twist ties, wire ties and any other tying devices are not permitted.
      - 2) One hole conduit straps are not permitted.
- I. OUTLET BOXES - Standard:
  1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Appleton
      - 2) Crouse-Hinds
      - 3) Steel City
      - 4) T & B
      - 5) Raco
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Outlet boxes and covers shall be galvanized pressed steel and plugged holes and shall be hot dipped galvanized or sherardized.
      - 2) The minimum box size shall be 4" square by 2-1/8" deep.
      - 3) Telephone and data outlets shall be a minimum of 4-11/16" square by 2-1/8" deep.
      - 4) Fire Alarm boxes shall be 4" square with plaster rings to suit type of device. Special boxes shall be as specified in Division 28.
      - 5) For boxes concealed in walls or ceiling, provide the solid gang, galvanized steel knockout type. Sectional boxes shall not be used.
      - 6) Light fixture outlet boxes shall be equipped with fixture-supporting device, as required by the unit to be installed.
      - 7) Switch Outlets: Use solid gang boxes for three or more switches for mounting behind a common single plate.
    - b) Preferred: None
    - c) Disallowed: None
- J. OUTLET BOXES – In Concrete:
  1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Appleton
      - 2) Crouse-Hinds
    - c) Disallowed: None

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2. Component Characteristics:
    - a) Required:
      - 1) Flush Mounted: Provide galvanized steel, 4" octagon rings with mounting lugs, back plate and adapter ring as required.
      - 2) Surface Mounted: Provide galvanized cast iron alloy; flat flanged box with threaded hubs and mounting lugs as required. Provide cast cover plate of same material as the box with ground flange, neoprene gasketed and stainless steel screws.
    - b) Preferred: None
    - c) Disallowed: None
- K. PULL AND JUNCTION BOXES:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) O.Z. Gedney
      - 2) Alhambra Foundry Co.
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Sheet Metal Pull and Junction Box: Provide standard outlet or concrete ring boxes wherever possible; otherwise use minimum 16 gauge galvanized sheet metal, NEMA 1 boxes, sized to Code requirements with covers secured by cadmium plated machine screws located 6 inches on centers.
      - 2) Cast Metal Pull and Junction Box: Provide standard cast malleable iron outlet or device boxes wherever possible; otherwise use cadmium plated, cast malleable iron boxes with bolt-on, interchangeable conduit hub plates with neoprene gaskets.
      - 3) Flush mounted pullboxes and junction boxes: Provide overlapping covers with flush head cover retaining screws, prime coated.
    - b) Preferred: None
    - c) Disallowed: None
- L. PRECAST CONCRETE BOXES:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Jensen
      - 2) Associated
      - 3) Quickset
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Provide high density reinforced concrete pull box with end and side knockouts and non-settling shoulders. Use cast iron lid with hold down bolts or use traffic rated covers in areas subject to vehicular traffic. Use composite reinforced concrete with hold down bolts and composite caps for sidewalks and non-vehicular areas.
    - b) Preferred: None
    - c) Disallowed: None



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- M. POKE-THROUGH:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) For new construction: Legrand/Wiremold, Evolution 6AT series (6" diameter)
      - 2) For existing buildings: Legrand/Wiremold, 4" diameter
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Provide recessed style multi-service, 2-hour fire rated, poke-thru devices with fully recessed device outlets that allow all plug-in devices and jacks to be fully contained within the compartment with cover closed and only cables visible.
      - 2) Provide poke thru devices complete with assembly, insert, activation cover, receptacles, communication modules mounting accessories, etc. and any additional accessories to facilitate the installation shown on drawings.
      - 3) Integral gasket shall be provided as part of the cover assembly to maintain scrub water tightness by preventing water, dirt and debris from entering the power and communication compartments.
      - 4) Provide Die-cast aluminum cover assembly in black finish or as directed by University.
      - 5) Furniture Feeds: Cat. # 6ATCFF-xx series with surface style cover.
      - 6) Misc. Devices: Cat. # 6STCP series with associated surface style cover Cat. # 6CTC-xx.
    - b) Preferred: None
    - c) Disallowed: None
- N. FLOOR BOXES:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Legrand/Wiremold
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Recessed Floor Boxes: Provide recessed gang able floor box with quantity and configuration of gangs as indicated on contract documents. Provide Die-cast aluminum flip lid cover assembly for use in tile or carpet installation in black finish or as directed by University. Use Cat. # 828r-TCAL and Cat. # 828COMTCAL series as required.
      - 2) Flush Floor Boxes: Provide flush multi-gang floor box for power, communication and other signaling systems as indicated on contract documents. Provide Brushed aluminum cover assembly for use in tile/carpet installation or as directed by University. Use Cat. # RFBx series boxes with associated Brushed Aluminum combination tile/carpet flanged cover assembly Cat. # FPBTCAL series.
      - 3) Boxes shall be complete with device plates, covers, devices, receptacles, etc. and any other accessories as required.

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- 4) All boxes shall have handle or means to easily open the box.
  - b) Preferred: None
  - c) Disallowed: None
- O. CONDUIT OUTLET BODY:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Appleton, type "LBD" or "LBDN" series
      - 2) Crouse-Hinds
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide Cadmium plated cast iron alloy, oblong conduit outlet bodies with threaded conduit hubs and neoprene gasket, cast iron covers where required. Condulets shall be cast iron with threaded hubs and gasket.
    - b) Preferred: None
    - c) Disallowed: None
- P. CONDUIT SEALS:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Appleton, type "ESUF" or "ESUM" series
      - 2) Crouse-Hinds, type "EYS" or "EZS" series
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide cast iron alloy for both body and closure. The seals shall have large openings with threaded closures to provide easy access to conduit hubs.
    - b) Preferred: None
    - c) Disallowed: None
- Q. WALL PENETRATION SEALS:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Link-Seal
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide modular water tight seals for all conduits penetrating exterior walls to prevent entrance of water inside the building.
    - b) Preferred: None
    - c) Disallowed: None
- R. EXPANSION COUPLINGS:
- 1. Manufacturers:
    - a) Required: No requirements

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- b) Preferred:
  - 1) O-Z/Gedney, Type "AX" or "DX" series
  - 2) Crouse-Hinds, Type "XD" or "XJD" series
- c) Disallowed: None
- 2. Component Characteristics:
  - a) Required:
    - 1) Provide expansion couplings in areas that two sections of conduit are subject to longitudinal movement due to thermal expansion, buckling and where crossing the structural joints.
  - b) Preferred: None
  - c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Installation – General:
    - a) Install Work in accordance with State and local standards and codes.
    - b) Arrange raceway and boxes to maintain headroom and present neat appearance.
    - c) Identify raceway and boxes in accordance with Section 26 05 53 "Identification for Electrical Systems"..
    - d) Ground and bond raceway and boxes in accordance with Section 26 05 26 "Grounding & Bonding for Electrical Systems"..
    - e) Fasten raceway and box supports to structure and finishes in accordance with this Section.
  - 2. Installation – Raceway:
    - a) Provide the type of raceway permitted in these Specifications or required for each location or condition per applicable codes and jurisdictions whichever is more stringent.
    - b) Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
    - c) Installation of raceways shall be coordinated with building structure and other trades and shall be complete with bends, fittings, junction and pull boxes to meet all codes and make complete operating system.
    - d) Upon completing the installation of any run of conduit, the runs shall be tested to see that they are free from all obstructions and have a smooth interior. Each end of each conduit run shall be plugged with "pennies" and bushings and left plugged until ready to pull circuit wires.
    - e) Raceways shall not be run in foundation, column, concrete slab, or in the plane of the concrete shear wall without written approval of the structural engineer and University for each individual run.
    - f) Raceways shall be concealed above ceiling, below floors and in walls, unless otherwise noted.
    - g) Where steel conduits enter a concrete floor below a surface mounted panelboard, they shall be encased in a concrete curb of sufficient height to match the height of the finished base tile.
    - h) Holes for conduits through existing concrete walls, manhole, or floors shall be made by the "core-drill" method. The size and location shall be approved by the University. All cores shall be fire-sealed properly.
    - i) Routing:

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- 1) Raceway routing is shown in approximate locations unless dimensioned.
  - 2) Route raceways parallel and perpendicular to walls and ceilings for all exposed and concealed locations, no jogging or zigzagging allowed.
  - 3) Route raceways in furred spaces to clear access openings.
  - 4) Route conduit in (where allowed) and under slab from point-to-point. Do not cross conduits in slab.
  - 5) Maintain minimum of 6 inch or larger clearance as required between raceway and piping for maintenance purposes.
  - 6) Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104°F such as hot water and steam pipes, flues, heating appliances and etc.
- j) Supports:
- 1) Raceway supports shall be dedicated to support the raceways only and shall not support any other item.
  - 2) Support raceways from structure above suspended ceilings; maintain minimum 8 inch or larger clearance above drop ceiling to allow removal of ceiling tiles. Maintain minimum 3 inch or larger clearance above recessed light fixtures.
  - 3) Do not attach raceway to ceiling support wires or other piping systems.
  - 4) Provide plated or galvanized hangers, rods, channels and metallic support and fastening material. Do not use perforated metal strap or wood as support material.
  - 5) Hangers and racks shall be attached to concrete with insets, set at the time the concrete is poured and to steel members with beam clamps or machine bolts.
  - 6) Conduit clamps and hanger rods attached to concrete structures shall be secured by machine bolts or rods screwed into anchors. Anchors not cast into the concrete shall be of the expansion shield type.
  - 7) Where single conduits 3/4 inch and larger are suspended from ceiling, use pipe hangers suspended from rods.
  - 8) Where two or more conduits 1-1/2 inch and larger are suspended from ceiling, use trapeze type hanger suspended from rods.
  - 9) Install fittings to accommodate expansion and deflection where raceway crosses seismic and expansion joints. Where Raceways cross the joints, provide approved expansion or deflection fittings, or combinations of fittings and liquidtight flex conduits to allow deflection in all directions as required.
  - 10) Raceways shall be continuous from outlet to outlet, from outlet to cabinet, junction box, pull box and shall enter and be secured to all boxes, etc., in such a manner that each system will be mechanically and electrically continuous from service to all outlets.
  - 11) Supports shall be installed for 3/4 to 1-1/4 inch conduits; within 18 inch of each junction box inclusive and on either side of couplings and fittings and at a spacing not to exceed 8 feet.
  - 12) Supports shall be installed for 1-1/2 inch and larger conduits; within 36 inch of each junction or pullbox and terminal cabinet and at a spacing not to exceed 8 feet.

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- 13) When conduits are supported from trapezes, the supports shall be spaced not more than 8 feet apart.
  - 14) Secure exposed conduit runs on concrete, plaster or other construction in place with cast conduit clamps affixed with metallic expansion anchors or toggle bolts and cadmium plated machine or lag screws.
  - 15) Surface Raceway: Install flat-head screws, clips and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
  - 16) Support raceways adjacent to walls with preformed channels.
  - 17) Do not strap or fasten rigid conduit to mechanical equipment, or to equipment subject to vibration or mounted on shock absorbing bases.
- k) Conduit Hangers:
- 1) Conduit straps, clips or hangers shall be used to mount conduit.
  - 2) Where conduit clips are used, preference is to mount on strut, rather than on wall.
- l) Seismic Bracing:
- 1) Provide seismic bracing for raceways consisting of (3)  $\frac{3}{4}$ " , or (2) 1" , or (1) 1-1/4" and larger or multi size combinations, wherever raceways are suspended more than 10 inch to the bottom of the raceway from its anchoring point on the structure. All such bracing as described herein or below shall be run from the raceway to the structure and anchored to the latter in an approved manner.
  - 2) Provide diagonal bracing every 16 feet to the structure from hangers and changes in direction.
  - 3) Seismic bracing as described above shall be provided immediately upon completion of each conduit run, to prevent obstruction of conduits by other utilities or construction work.
- m) Bends:
- 1) Keep bends and offsets in raceway runs to an absolute minimum. There are no zigzagging or small jogging permitted.
  - 2) Install no more than equivalent of four 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams.
  - 3) Conduit bends will not be permitted around the corners of beams, walls or equipment. Provide condulets as required with accessible covers.
  - 4) For bends and offsets in conduit 1 inch and larger, use larger radius factory fittings or a hydraulic bender. Replace flattened, deformed or kinked conduit.
  - 5) For the serving utilities the bending radius of raceways shall meet their requirements.
- n) Cuts and Joints:
- 1) Cut conduit square using saw or pipe cutter; de-burr cut ends.
  - 2) Cut conduit squarely and ream ends to remove burrs. Close open ends of conduits, unless in a closed box or cabinet, with approved conduit caps or closures as soon as installed and keep closed until ready to pull in conductors.

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- 3) Ream the ends of all conduits and clean conduits before pulling conductors.
  - 4) Where conduit is underground, under slabs or grade, exposed to the weather, or in wet locations, make joints liquid tight and gas tight.
  - 5) For rigid steel conduit use conduit unions to connect two rigidly held conduits. Running thread will not be accepted.
  - 6) Cut threads on rigid conduit to standard taper and to length such that bare metal exposed by the threading operation will be completely covered by the couplings or fittings used.
  - 7) Use pipe joint compound (pipe dope) and oil applied to the male threads only and tighten joints securely.
  - 8) For underground or under slab conduits, apply a heavy coat of Pabco P & B No. 2 paint after installation to surfaces within 6" on both sides of fittings and to areas where wrenches or other tools have been applied.
  - 9) For exposed conduits, repair scratches and other defects with galvanizing repair stick, Enterprise Galvanizing "Galvabar", or equal.
  - 10) Right- and left-hand couplings shall not be used.
  - 11) Make all fittings in plastic conduit watertight with approved solvent-weld cement specifically manufactured for the purpose and approved by PVC conduit manufacturer.
- o) Terminations:
- 1) Secure conduits to panels, pull boxes, wireways and enclosures with locknuts, inside and out and provide high impact plastic or insulated throat steel bushings at terminations in pull boxes, wireways, signal cabinets, boxes and enclosures.
  - 2) For rigid steel conduit, provide steel insulating bushings with plastic liner.
  - 3) For EMT provide insulated throat connectors secured with locknut on interior of box or enclosure.
  - 4) For flex conduit, provide insulated throat steel twist-in connectors secured with locknut on interior of the box or enclosure, or steel twist-in connectors with plastic bushing and locknut.
  - 5) At panelboards, switchboards and gear specified with ground bus terminate conduits with ground bushing bonded to ground bus with code size conductor.
  - 6) Conduit connections to panel cabinets and pull boxes shall have grounding wedge lugs between the bushing and the box or locknuts designed to bite into the metal.
  - 7) Use approved couplings or unions; running thread, thread less coupling, or split coupling connections are not permitted.
  - 8) Use insulated bushings and locknuts on all conduits where entering pullboxes, junction boxes, outlet boxes, cabinets and similar enclosures and for all signal and telephone conduit terminated in cabinets or backboards. For 1-inch or larger bushings, shall be with grounding lugs, O-Z/Gedney Type BLG or equal. Bushings shall be installed before any wire is pulled.
  - 9) For all PVC jacketed steel conduits wrap all joints with two layers of 10 mil PVC tape.
  - 10) Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining.

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Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

- p) Sleeves:
- 1) Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.
  - 2) Wherever conduits pass through concrete walls, suspended slabs or metal deck floors furnish and install sleeves of ample size to permit installation of conduit. Sleeves shall be installed prior to pouring of concrete and shall have ends flush with the wall or extend 2 inches above floor surfaces. Verify locations with the University's Representative.
  - 3) Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 4) Use rectangular sleeve (minimum of 0.052-inch thick steel) for openings that the perimeter is less than 50 inches and all sides are less than 16 inches.
  - 5) Use rectangular sleeve (minimum of 0.138-inch thick steel) for openings that the perimeter is equal or greater than 50 inches and one or more sides are equal or greater than 16 inches.
  - 6) Cut sleeves to length for mounting flush with both wall surfaces.
  - 7) Extend sleeves installed in floors 2 inches above finished floor level.
  - 8) Finish around Sleeves: Rough edges shall be finished smooth.
  - 9) Space between conduit and sleeves where conduit passes through exterior walls shall be sealed to permit movement of conduit, but prevent entrance of water.
  - 10) Space between conduit and sleeves where conduit passes through fire rated interior walls and slabs shall be sealed with approved materials to provide a fire barrier conforming to the requirement of Codes as listed in General Requirements.
  - 11) Sleeve shall be 1 inch To 2 inch bigger than conduit size.
- q) Empty Raceways:
- 1) Install suitable pull string or cord in each empty raceway except sleeves and nipples.
  - 2) Provide nylon or polypropylene pull ropes in all conduits more than 60 inch in length that are left empty for future use. Minimum of 60 inch of rope shall be provided at each end of the conduit.
  - 3) For 1-1/2 inch and smaller conduits, provide 1/8 inch outside diameter rope.
  - 4) For 2 inch and larger conduits, provide 3/8 inch outside diameter rope.
  - 5) Tag all empty conduits at each accessible end with a permanent tag identifying the purpose of the conduit and the location of the other end.
  - 6) In wet, corrosive outdoor or underground locations, use brass, bronze, or copper 16 gauge tags or lead tags secured to conduit ends with #16 or larger galvanized wire.
  - 7) Inscribe on the tags, with steel punch dies, clear and complete identifying information.
  - 8) Install suitable caps, recommended by manufacturer, to protect installed conduit against entrance of dirt and moisture until ready to pull in conductors.

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- 9) All open ends of conduits for communications cabling shall be furnished with plastic bushing.
- r) Seals:
  - 1) Conduits terminating where termination is subject to moisture or where conduit penetrates exterior wall shall be sealed.
  - 2) Seal all conduits from exterior outlets at first interior junction to prevent moisture from entering the building through the conduit. Slope exterior conduits away from the building.
  - 3) Provide conduit seal for all conduits that pass through Classified (hazardous) areas, sump pump and sewage ejector pits, refrigerated areas, temperature controlled rooms such as cold room or warm rooms.
  - 4) Seal all fire rated wall or ceiling penetrations. Sealant material and method shall be UL listed.
3. Raceway Application:
  - a) Rigid steel conduit shall be used for the following:
    - 1) Where required by Code.
    - 2) Where exposed to weather, damp and wet locations
    - 3) Where exposed to physical damage
    - 4) In Cold Rooms and refrigerated area (65°F or less).
    - 5) Generator enclosure
  - b) EMT conduit shall be used for the following:
    - 1) EMT conduit shall be used for all sizes up to 4" in dry locations as in stud partitions and furred ceiling space.
    - 2) EMT conduit may be used up to 4" for Telecommunication and Voice/Data System.
    - 3) EMT conduit may be used up to 4" for Fire Alarm System wiring where conduit is concealed and where it is not main run and riser.
    - 4) EMT conduit shall not be used for underground, exterior, where it is prohibited and where rigid steel conduit is required.
  - c) Flexible steel conduit shall be used for the following:
    - 1) Where required by Code.
    - 2) In dry locations.
    - 3) Where structural condition prevents the use of other type of conduit and for a maximum length of 24".
    - 4) For final connection to motors, transformers and vibrating equipment. Lengths shall be limited to within maximum of 6'.
    - 5) For final connection from junction box to light fixture. Lengths shall be limited to within maximum of 6'.
  - d) Liquidtight Flexible conduit shall be used for the following:
    - 1) Where required by Code.
    - 2) In plenum areas.
    - 3) Where exposed to weather, in damp or wet locations.
    - 4) In refrigerated areas (65°F or less).
    - 5) Between the seismic joints.
    - 6) For connections to equipment containing water (i.e. water heaters)
    - 7) Any connections made below sinks.
    - 8) Provide polyvinyl covers listed for the application of area of use.
    - 9) Minimum length of flexible liquidtight conduit shall be 3' for connection to motors and vibrating equipment. The lengths shall be limited to a maximum of 6' unless otherwise noted.



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- e) Rigid nonmetallic conduits, PVC Schedule 40 shall be used for the following:
    - 1) For 4800V and greater, encased in concrete at a minimum depth of 36" below grade.
    - 2) For 480V and below in pedestrian hardscape and in landscape areas, surrounded with 3" single sack slurry all around the conduit at a minimum depth of 36" below grade.
    - 3) For 480V and below in hardscape areas subject to vehicular traffic:
      - i. For 2" and larger size conduit encased in concrete at a minimum depth of 36" below grade.
      - ii. For 1-1/2" and smaller size conduit surrounded with 3" single sack slurry all around the conduit at a minimum depth of 36" below grade
  - f) PVC coated steel conduits shall be used in lieu of rigid nonmetallic conduit for the following conditions or locations:
    - 1) In corrosive and/or moist areas
    - 2) Use for all cooling tower areas
    - 3) Use for all conduit stub-ups through the floor slab, including the elbows.
    - 4) Use for all conduit penetrations through the exterior walls, including 36" on either side of the penetration.
    - 5) For all bends in conduits 2" and larger, use large radius factory made bends or field fabricate with a power bender.
    - 6) All conduits and fittings that have a damaged PVC coating shall be replaced promptly.
4. Installation – Boxes:
- a) Provide the type of boxes permitted in these Specifications or required for each location or condition per applicable codes and jurisdictions whichever is more stringent.
  - b) Install boxes in accordance with manufacturer's written instructions, as shown on drawings and as specified herein.
  - c) Provide pull boxes inside the building to facilitate pulling of conductors and cables for long and excessive runs of raceways. The spacing of pullboxes shall not exceed 200 feet of raceway runs for electrical system and 100 feet for telecommunications system. These pullboxes are not necessarily indicated on drawings. (Coordinate telecommunication requirements with Division 27.)
  - d) All boxes shall be of CEC size for the number of wires or conduits passing through or terminating therein, but in no case shall any box be less than 4" square by 2-1/8" deep, unless specifically noted as smaller on the Drawings.
  - e) Locate electrical boxes as shown on Drawings and in other locations as required for splices, taps, wire pulling, equipment connections, Code compliance and other building elements.
  - f) Prior to coring existing slab for poke-thru devices, coordinate with structural engineer and University's Representative for approval.
  - g) Install outlet boxes at the locations and elevations shown on the Drawings or specified elsewhere. Make adjustments to locations as required by structural conditions and to suit coordination requirements of other trades.

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- h) Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only such as electrical rooms, mechanical rooms and utility areas.
- i) In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- j) Do not install flush mounting boxes back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic and fire rated walls.
- k) For boxes not specified or indicated, use boxes and mounting height as required by equipment and recommended by equipment manufacturer.
- l) Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- m) Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- n) For boxes mounted in exterior walls, make sure that there is insulation behind outlet boxes to prevent condensation in boxes.
- o) Use extension rings with blank covers for making exposed conduit connections to flush wall or ceiling boxes.
- p) Locate outlet boxes to allow light fixtures positioned as indicated on Drawings.
- q) Locate switch outlet boxes on the latch side of doorways unless otherwise indicated.
- r) Install gang box where more than one device is to be mounted together. Do not use sectional box.
- s) Install gang box with plaster ring for single device outlets.
- t) Supports:
  - 1) Support boxes independently of conduit system:
  - 2) Install stamped steel bridges/brackets to fasten flush mounting outlet box between studs.
  - 3) Install adjustable steel channel fasteners for hung ceiling outlet box.
  - 4) Do not fasten boxes to ceiling support wires or other piping systems.
  - 5) Support boxes, installed in suspended ceilings supporting acoustical tiles or panels, directly from the structure above wherever pendant mounted lighting fixtures are to be installed from the box.
  - 6) Mount boxes, installed in suspended ceilings of gypsum board or lath and plaster construction, to 16 gauge metal channel bars attached to main ceiling runners.
- u) Boxes for different systems:
  - 1) Where both emergency and normal circuits feed a single light fixture, provide an outlet box for each system.
  - 2) Provide separate pull boxes and J-Box for different voltage conductors. Also provide separate boxes for general loads, communications, fire alarm, lighting, signal and miscellaneous systems.
  - 3) Multiple gang boxes containing 277volt switches shall have a barrier between each switch.
  - 4) Paint the outside and inside of all boxes containing fire alarm devices with red paint.
- v) Covers:
  - 1) Covers for flush outlets shall finish flush with plaster or other finished surface.

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- 2) Install raised covers (plaster rings) on all outlet boxes in stud walls or in furred, suspended or exposed concrete ceilings. Covers shall be of a depth to suit the wall or ceiling finish.
  - 3) For outlets flush in exterior walls, use weatherproof joints and connections all around. Outlets shall have cast covers and be fitted with gaskets.
  - 4) Label the cover of each accessible junction box with panel and circuit designation and function per Section 26 05 53 "Identification for Electrical Systems"..
  - 5) Install galvanized steel coverplates on boxes in unfinished areas, above accessible ceilings and on surface mounted outlets.
  - 6) Provide cast metal boxes with gasketed cast metal cover plates where boxes are exposed in damp or wet locations.
- w) Use conduit outlet bodies to facilitate pulling of conductors or to make changes in conduit direction only. Do not make splices in conduit outlet bodies.
- x) Leave no unused openings in any box. Install close-up plugs as required to seal openings.
- y) J-Boxes shall not be installed on any vibrating equipment (I.e. pumps, fans, etc.) unless used for power or control of the same equipment. No J-Box shall be installed on air ducts or pipes.
- z) J-Boxes shall not be installed in visible finished areas. Place boxes that might be exposed to public view in a location approved by the University's Representative. Provide covers or plates to match adjacent surfaces as approved by the University's Representative.
- aa) For exterior underground conduit runs provide precast concrete boxes in exterior planting areas, walkways and etc. Provide 6" deep gravel base under each box.
- bb) Prior to coring existing floor slab for floor devices, coordinate with structural engineer and the university for approval.
5. Miscellaneous Items:
- a) Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Division 07.
  - b) Provide fire-proofing pad add additional sheet rock as necessary to maintain original fire rating of walls where boxes are installed on rated walls.
  - c) Provide acoustic pad or membrane around all outlet boxes and switches located in party walls of offices, meeting rooms and all quiet areas.
  - d) Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.
  - e) Wherever conduit extends through roof, furnish and install galvanized sheet metal flashing. Flashing shall extend six inches above roof.
6. Adjustments:
- a) Align adjacent wall mounted outlet boxes for switches, thermostats and similar devices.
  - b) Adjust flush-mounting outlets to make front flush with finished wall material.
  - c) For outlets mounted above counters, benches or backsplashes, coordinate location and mounting heights with built-in units. Adjust mounting height to agree with required location for equipment served.

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- d) In concrete or drywall construction, set recessed boxes so that the front of the plaster ring or front of the box for those without plaster rings is not more than 1/4" behind the final finished surface.
- e) Set all recessed boxes in other types of construction so that the fronts are flush with the finished surface. Where these settings are not achieved, provide a 24-gauge or heavier galvanized steel liner flush with finished surface.
- f) Adjust position of outlet boxes in finished masonry walls to suit masonry course lines. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate cutting of masonry walls to achieve neat openings for boxes.

B. Preferred: None

C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
N/A
- B. Documentation required:
  - 1. Test reports: N/A
- C. Required testing protocols:
  - 1. General: N/A

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 0553 IDENTIFICATION FOR ELECTRICAL SYSTEMS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 27 26 and 33 7119.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X			

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to Identification for Electrical Systems.
    - b) All electrical equipment, devices, raceways, conduits, boxes, cables and conductors shall be labeled for identification as stated and per following codes and standards:
      - 1) Comply with CEC
      - 2) Comply with 29 CFR 1910.144 and 29 CFR 1910.145
      - 3) Comply with ANSI Z535.4 for safety signs and labels.
      - 4) Adhesive-attached labeling materials shall comply with UL969.
      - 5) Furnish products listed and classified by Underwriters Laboratories, Inc. or by a testing agency acceptable to Authorities Having Jurisdiction as suitable for purpose specified and indicated.
  - 2. Preferred: None
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Markers:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Thomas & Betts
      - 2) Brady
    - c) Disallowed: None

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2. Component Characteristics:
    - a) Required:
      - 1) Provide identification devices in accordance with manufacturer's written instructions and requirements of the CEC.
    - b) Preferred: N/A
    - c) Disallowed: N/A
- B. Tapes:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Kroy
      - 2) Merlin
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Provide identification devices in accordance with manufacturer's written instructions and requirements of the CEC.
    - b) Preferred: N/A
    - c) Disallowed: N/A

## 4. INSTALLATION REQUIREMENTS

- A. Required:
1. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated on the drawings. Provide numbering, lettering, and colors as approved in submittals and as required by Code.
  2. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
  3. Nameplates – General:
    - a) Provide laminated, engraved plastic nameplates with  $\frac{3}{8}$  inch high letters for all switchgear, switchboards, motor control centers, transfer switches, panelboards, signal system equipment cabinets, and terminal cabinets. Provide similar nameplates with  $\frac{3}{8}$  inch high letters for transformers, time switches, individually mounted breakers, switches and controls, switchboards, and motor center branch devices. Attach nameplates to gear with sheet metal screws. Adhesive mounted nameplates are not acceptable. Refer to single line diagrams and schedules for actual designations and circuit numbers that apply to this project.
    - b) Include nameplate schedule on shop drawing submittals.
    - c) Indicate on Gear Nameplates:
      - 1) Line 1: Equipment designation
      - 2) Line 2: Primary voltage, phase, number of wires. (In addition, include kVA rating of transformers, kW rating generators, Amperes for switchgear, Automatic Transfer Switches, and panelboards).
      - 3) Line 3: Source equipment "Fed From" (For Automatic Transfer Switch, indicate normal and emergency source equipment and for equipment fed from a transformer, indicate source with transformer in parenthesis).

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- 4) Line 4: (where applicable, For Automatic Transfer Switch, indicate priority number.)
  - 5) Example #1:  
Distribution Board DBHN1  
480/277V, 3P, 4W, 2000A
  - 6) Example #2:  
ATS E-AH1  
480/277V, 3P, 4W, 600A  
NORMAL SOURCE: DBHN1, EMERGENCY SOURCE: E-DBHN1  
PRIORITY 1
  - 7) Example #3  
PANEL LN1A  
120/208V, 3P, 4W, 150A  
FED FROM DBHN1 (VIA T1A)
- d) Indicate equipment and/or equipment controlled and designation on component nameplates. Examples:
    - 1) Switchboard Breaker: CKT 3 – PANEL LN1A
    - 2) Motor Switch: TOILET EXHAUST FAN EC-3
    - 3) Submeter: KWHR SUBMETER AIR CONDITIONING
    - 4) Time-Switch: TSA – PARKING LIGHTS (served from Panel A)
    - 5) Fire Alarm Terminal Cabinet: FIRE ALARM SYSTEM 24V DC
  - e) Install panelboard nameplates behind panel door in public areas and on panel face in equipment rooms.
4. Nameplate Color Schedule:
- a) Over 600V: Brown letters on white label.
  - b) 277 through 600V: Orange letters on white label.
  - c) 120 through 240V: Black letters on white label.
  - d) Emergency System: White letters on red label.
  - e) Devices Connected ahead of Service Mains and Substation Secondary Mains: Letter color as per switchboard voltage on Yellow label.
  - f) Fire Alarm System: Black letters on red label.
  - g) Communication or Signal Systems: White letters on black label. Identify system and voltage.
  - h) Building Control System: White letters on green label.
5. Stenciled Designations: Provide readily visible block letter stenciled designations for the following with  $\frac{3}{8}$  inch high minimum letters on background of contrasting colors as outlined under Nameplate Color Schedule (above). Fabricate stencils of brass and deliver to Owner on completion of work. Obtain receipt and include in maintenance manual.
- a) Junction and pull boxes of signal and communication systems identifying system and voltage.
  - b) Lighting Outlet and Junction Boxes: Identify voltage and circuits contained within box.
  - c) 480V Outlet and Junction Boxes: 480V. Identify circuit(s).
  - d) Each 10 foot length of medium voltage conduit, exposed or in accessible ceiling space and associated junction and pull boxes: DANGER HIGH VOLTAGE
  - e) Feeder conduit runs on 25 foot centers and on both sides of wall and floor penetrations, where visible from floor and above demountable ceilings.

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Indicate circuit designation and number on all feeders. Indicate system on all signal and communications system conduit sized 1½ inch and larger.

6. Labels:
  - a) Provide label, in addition to UL label, for each switchgear, switchboard, panelboard, transfer switch, and motor control center indicating the short circuit rating of the gear as constructed and the minimum rating of devices allowable. Submit with shop drawings.
  - b) At all 120V outlet locations, provide labels with panel and circuit information using a P-touch or similar label maker with minimum ½" tape. For normal power, label shall be black letters on white tape. For emergency power, label shall be white letters on red tape.
  - c) At all dedicated outlet locations, in addition to label as indicated in 'b)' above, provide the name of the device to be connected at the dedicated outlet on the label. Example " L1A-13, Freezer"
  - d) At all fusible devices, either individually mounted or part of gear, provide a label (as supplied by fuse manufacturer) or nameplate inside each switch cover, indicating specific type of fuse required for replacement.
7. Emergency System:
  - a) Identify all enclosures per Article 700 of the CEC
  - b) Paint junction box covers and covers of multi-outlet assemblies' red.
  - c) Use visibly red receptacles and devices. Alternately, engrave plates "EMERGENCY SYSTEM" and fill in with red enamel.
8. Conduit and Conductors:
  - a) Tag feeders at panels, switchboards, pull boxes, and other accessible enclosures, indicating source, voltage, circuit number, and conductor ampere rating. Tags to be readily readable after installation.
  - b) For feeder tags in Manholes and Handholes, refer to 33 7119 Electrical Underground Manholes and Handholes.
  - c) Identify medium voltage conductors with phase and circuit number.
  - d) In exterior or wet locations, and for medium voltage conductors in all locations, provide tag Fasttag Miniature Markers or equal type system, single line, with 3/16 inch minimum high letters, yellow background, and tied with No. 16 AWG galvanized wire.
  - e) In interior dry locations, provide metal or laminated plastic discs as above, attached with nylon cord.
  - f) Tag exposed ends of conduit stubs indicating system, name of panel, switchboard, etc., of origin and conduit size.
  - g) Identify all branch circuit system conductors with pre-marked self-adhesive, wrap around cloth wire markers, indicating circuit number and name of panel, cabinet, etc, or origin, at panelboards, motor control centers, switchboards, isolated power panels, terminal cabinets, wireways, junction boxes and at all outlet boxes containing more than one neutral wire.
  - h) Identification Format Example:
    - 1) Switchboard Feeder – DBHN1-1 480/277V 225A
    - 2) Transformer Subfeeder - T1A 208/120V 380A
    - 3) Transfer Switch Subfeeder - EAH1 480V 800A
    - 4) Panel Branch Circuit - LN1A-10
  - i) Underground Electrical Line Identification: Install line marker for underground wiring, both direct-burial and in raceway. During trench backfilling, for underground power, signal, and communication lines, install continuous underground plastic line marker, located directly above line 6 to



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- 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width of 16 inches, install a single line marker.
- j) Provide, above underground conduits stubbed for future use, engraved flush bronze marker anchored in 4 inch square by 12 inch deep concrete block, flush with grade, indicating system, conduit size and point of origin.
  - k) Paint Fire Alarm System J-boxes and pullboxes red and provide label: "Fire Alarm System".
9. Identify Raceways of Certain Systems with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be painted with colors indicated below. Make each color band 2 inch wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors, and at 10 foot maximum intervals in straight runs. Apply the following colors:
- a) Fire Alarm Systems: Red.
  - b) Fire Suppression Supervisory and control System: Red and Yellow
  - c) Mechanical and Electrical Supervisory System: Green and White
  - d) Telephone System: Green and Yellow
10. Conductor Color Coding: provide color coding for secondary service, feeder, and branch circuit conductors throughout the project secondary electrical system as follows:

<u>208/120 Volts</u>	<u>Phase</u>	<u>480/277 Volts</u>
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

11. Use conductors with color factory-applied the entire length of the conductors except as follows:
- a) The following field-applied color coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG:
    - 1) Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or tape are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1 inch wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
    - 2) In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

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- 3) Color coded conductors of cables used in communication and signal systems and control conductors in line and low voltage control panels, motor control centers, and supervisory panels. Use white for grounded conductors and green for equipment ground, exclusively.
12. Devices: Engrave on each device plate with 3/16 inch high block letters with black enamel where noted and as follows:
  - a) Lock switch and switch with pilot light – device controlled.
  - b) Switch for fan, motor unit heater – equipment controlled.
  - c) Switch where lights or equipment are out of sight – identify area or equipment controlled.
  - d) Switches in gangs of three or more – identify areas or equipment switched.
  - e) Receptacles over 150V to ground and/or 30A and higher rating – voltage and ampere rating.
  - f) Isolated Ground Receptacles – Isolated Ground.
  - g) Where wording is not indicated, allow for ten letters per device and use wording as directed.
  - h) For switch cabinets engrave each device or provide engraved nameplate.
13. Warning Signs: Conform with the latest edition of the NEC. Provide No. 18 AWG steel, white porcelain enameled signs with 1 inch high letters to read “DANGER! – HIGH VOLTAGE, AUTHORIZED PERSONNEL ONLY!”. Post on doors or entries to all rooms or areas containing equipment rated over 600V and on front of such equipment enclosures. Provide similar signs with 1 inch high black letters in all electrical and signal rooms and closets reading “ELECTRICAL (or SIGNAL) ROOM – NO STORAGE PERMITTED”. Submit shop drawings.
14. Panel Schedules:
  - a) Provide typewritten panel schedules on inside of panel doors behind clear plastic. Indicate as-built quantity and type of outlets served as well as general location of outlets or fixtures and/or item of equipment served.
  - b) Electronic copies of all panel schedules shall be provided as part of close out documentation. Electronic panel schedules may be provided in Microsoft Excel or AutoCAD formats only. Scanned or other non-editable electronic files are not acceptable.
15. Diagrams and Posted Signs:
  - a) For switchboards with bus rating 1000A or greater, and for substations, provide a bus diagram framed and mounted behind clear plastic indicating bus configuration and rating, devices, ground fault detectors, standby

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generator connection, and switchboard components. Submit diagram for review with shop drawings.

- b) For signal and communication systems, provide block wiring and location diagram mounted behind clear plastic and posted at system control location or as directed. Submit diagram for review with shop drawings.
- c) For medium voltage switchgear, provide a single line bus diagram air brush painted in contrasting color across the front face of the switchgear indicating all components within cubicles including lightning arresters, metering, etc.
- d) For all main electrical rooms, and/or as directed by Owner, provide a single line diagram framed and mounted behind clear plastic indicating as-built system configuration and distribution.

B. Preferred: None

C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

A. N/A

**END OF DOCUMENT**

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## 26 0573 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section includes services necessary to complete the system analysis studies required for the Overcurrent Protective Device Coordination Study which includes short circuit coordination study, protective device evaluation study, and protective device coordination study.
    - b) The studies shall include all portions of the electrical distribution system from the normal to emergency power source or sources down to and including the smallest circuit breaker in the distribution system.
    - c) An independent consulting or testing company not involved on the project shall perform the study and prepare a complete and detailed report.
    - d) The firm performing the study should be currently involved in high- and low-voltage power system evaluation. The study shall be performed, stamped and signed by a local registered professional electrical engineer. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the University for approval prior to start of the work.
    - e) A minimum of ten (10) years experience in power system analysis is required for the individual in charge of the study.
    - f) The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.
  - 2. Preferred: None.
  - 3. Disallowed: None.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.

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### 3. PRODUCT REQUIREMENTS

#### A. General Requirements:

1. Firms:
  - a) Required: No requirements.
  - b) Preferred:
    - 1) KSG Consulting Engineers, Inc.
    - 2) Applied Engineering Concepts
    - 3) Electrical Reliability Services
  - c) Disallowed: None.
2. Studies:
  - a) Required:
    - 1) Provide short-circuit and protective device evaluation study as prepared by the independent consultant.
    - 2) The studies shall be performed with the aid of a computer program and shall be in accordance with the latest applicable IEEE and ANSI standards. For computer software, use the most recent version of SKM power tools for windows or approved equal.
    - 3) A protective device evaluation study shall be performed to determine the adequacy of circuit breakers, switches, automatic transfer switches and fuses by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied. Any problem areas or inadequacies in the equipment due to short circuit currents shall be promptly brought to the university's attention.
    - 4) A protective device coordination study shall be performed for the entire electrical distribution system to provide the necessary calculations and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, ground fault relays and low voltage breaker trip characteristics and settings. The studies shall be in accordance with the latest applicable IEEE and ANSI standards.
  - b) Preferred: None.
  - c) Disallowed: None.
3. Report:
  - a) Required:
    - 1) The report shall be neatly bound in an 8-1/2" x 11" folder or binder with a table of contents and separate tabs for each section of report.
    - 2) The report shall include a detailed description, purpose, basis and scope of the study.
    - 3) The report shall include several sections of the electrical distribution system with single line diagram, description and listing of devices and equipment that are representative of every individual situation or connection. Protective device time versus current coordination curves, circuit breaker and fuse selection with commentary regarding any component shall be provided for each section.

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- 4) Provide tabulations of all circuit breakers, fuses and other protective device ratings versus calculated short circuit duties. Provide commentary for each device that is not meeting the acceptable values calculated by the study and make recommendations for any modifications as required.
- 5) Fault current calculations including a definition of terms and guide for interpretation of computer printout shall be provided.
- 6) Recommended size for power fuses and recommended settings for ground fault relays and for all adjustable trip relays shall be provided.

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. The equipment manufacturer shall provide the services of a qualified field engineer and necessary tools and equipment to test and calibrate the protective relays, ground fault relays and circuit breaker trip devices as recommended by the coordination Study
2. Upgrade and modification to equipment characteristics and ratings to be finalized by the results of the Short Circuit and Protective Device Coordination Studies.
3. Field settings of devices, adjustments, upgrading and modifications to the new equipment to accomplish conformance with the accepted Short Circuit, Protective Device Coordination and Arc Flash Studies, shall be carried out by the Contractor at no additional cost to the University. The Contractor shall not be responsible for upgrading the existing equipment unless otherwise directed.
4. Notify University's Representative in writing of any required major equipment modifications.
5. Provide arc flash labels for all buses as required per Code and City of LA.
6. Engineering report number, revision number and issue date
7. Labels shall be machine printed, with no field markings.
8. Equipment shall not be energized until the breakers have been set and tested to the pickup levels determined by the approved final power system study.

B. Preferred: None.

C. Disallowed: None.

### 5. EVALUATION or COMMISSIONING

A. N/A

**END OF DOCUMENT**

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## 26 0810 TESTING OF ELECTRICAL SYSTEMS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Commissioning Standard Guidelines separate of this document.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to testing of electrical systems.
      - 1) The following testing shall be performed by an independent testing company:
        - Service Grounding Test
        - Ground Fault Protection Systems Test & Calibration
        - Transformers, Dry Type
        - Motor Controllers
        - Circuit Breaker Tests
        - Switchboards
        - Panelboards
        - Generator
        - Automatic Transfer Switches
        - UPS
        - Metering Test and Calibration
        - The following testing shall be performed by the contractor:
          - Fire Alarm Systems
          - Receptacle and Device Tests
          - 600 volt wiring
          - Power System Tests
          - Variable Frequency Drives
          - Fan Shutdown Systems
          - Smoke Damper Control

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- 2) Test and provide written certification that the entire electrical installation complies with contract documents, code and proper system operation. Perform acceptance tests in accordance with manufacturer's recommendations, NFPA 70b and InterNational Electrical Testing Association (NETA) testing specifications NETA ATS-2009.
  - 3) Qualifications of testing agency
    - i) The testing firm shall be an independent testing organization that can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers and installers of equipment or systems evaluated by the testing firm.
    - ii) The testing firm shall meet the criteria for Full Membership or be a Full Member company of the InterNational Electrical Testing Association (NETA).
    - iii) A minimum of ten (10) years experience in testing electrical equipment is required for the individual in charge of the project.
    - iv) The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.
    - v) The testing firm shall only utilize full-time engineers who are regularly employed by the firm for testing services.
    - vi) All on-site personnel shall have a minimum of 5 years of experience in electrical equipment startup and testing.
    - vii) The firm shall provide a competent project engineer to oversee and coordinate all site work and shall be on site whenever 3 or more of the firm's engineers are on site.
  - 4) Test instrument
    - i) Utilize a calibration program that assures that all applicable test instruments are maintained within rated accuracy.
    - ii) Accuracy directly traceable to the National Institute of Standards and Technology
    - iii) Calibrate Field Instruments: Analog – every 6 months maximum; Digital – every 12 months maximum.
    - iv) Calibrate Laboratory Instruments every 12 months.
    - v) Calibrate Leased Specialty Equipment every 12 months (Where accuracy is guaranteed by leaser).
    - vi) Maintain dated calibration labels visible on all test equipment.
    - vii) Keep records that show date and results of instruments calibrated or tested up-to-date.
    - viii) Maintain up-to-date instrument calibration instructions and procedures.
2. Preferred: None.
  3. Disallowed: None.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS

- A. General Requirements:
1. Testing Company: Retain the services of an independent testing company that is qualified to test electrical equipment and is an approved testing company by the



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State of California. The testing company shall not be associated with the manufacturer of equipment or systems under test. Testing company shall prepare typewritten reports on all the systems they test.

- a) Required: None.
  - b) Preferred:
    - 1) Electro-Test Inc. (ETI)
    - 2) Applied Engineering Concepts (AEC)
  - c) Disallowed: None.
2. Test Equipment:
- a) Required:
    - 1) The contractor shall provide all apparatus and material required for testing. The contractor shall use installation tools and test equipment that are designed for the specific task and shall use this equipment per the manufacturer's instructions.
    - 2) All test equipment shall have current calibration certification by a third party calibration laboratory and shall have a signed and dated calibration sticker affixed to the device. Calibration shall be traceable to the national bureau of standards and shall not be less than 6 months since last calibration. Defective test equipment and installation tools shall not be used. Installation tools such as torque wrenches shall be calibration certified.
  - b) Preferred: None.
  - c) Disallowed: None.
3. Project Documents:
- a) Required:
    - 1) The contractor shall send or deliver the following project documents to testing company two weeks prior to testing:
      - i) Division 26 Specifications.
      - ii) Electrical Floor Plans showing equipment to be tested.
      - iii) Electrical One-Line Diagrams.
      - iv) Submittals of Manufacturer's Data and Shop Drawings including engineers review letter of all systems to be tested.
      - v) Over current protective device and Coordination Study.
      - vi) Arc Flash Hazard Analysis Study
  - b) Preferred: None.
  - c) Disallowed: None.

#### 4. INSTALLATION REQUIREMENTS

- A. N/A Required:

#### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Tests.
- B. Documentation required:
  - 1. Test reports: Testing company shall prepare typewritten reports on all the systems they test.

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2. Labels: Upon completion of testing agency tests a NETA label shall be attached to all serviced devices. These labels shall indicate date serviced and the testing company.
- C. Required testing protocols:
1. Tests to be performed by testing company:
    - a) Service Grounding Tests:
      - 1) Perform fall-of-potential tests on main grounding electrode system provided by this contract per IEEE Standard No. 81. Maximum resistance to ground shall be less than 5 ohms. If this resistance cannot be obtained with the ground system shown, notify the University's Representative immediately for further instructions.
      - 2) Confirm that the neutral is grounded only at the service equipment by removing the service neutral grounding conductor and meggering the neutral bus.
      - 3) Refer to Grounding section 26 05 26 "Grounding & Bonding for Electrical Systems" for additional testing and requirements.
    - b) Ground Fault Protection Systems Tests:
      - 1) Scope:
      - 2) Prior to Test: Inspect neutral main bonding connection to assure:
        - i) Zero sequence system is grounded upstream of sensor
        - ii) Ground connection is made ahead of neutral disconnect link
        - iii) Ground strap systems are grounded through sensing device
        - iv) Verify ground electrode conductor(s) for proper size and connection
      - 3) Inspect control power transformer to insure adequate capacity for system.
      - 4) Monitor panels (if present) shall be manually operated for:
        - i) Trip test
        - ii) No trip test
        - iii) Non-automatic reset
      - 5) Proper operation and test sequence shall be recorded.
      - 6) Zero sequence systems shall be inspected for symmetrical alignment of core balance transformers about all current carrying conductors.
      - 7) Ground fault system integral to the circuit breaker will have its current sensors and neutral sensor inspected for proper polarity.
      - 8) Ground fault device circuit nameplate identification shall be verified by device operation.
      - 9) Pickup and time delay settings shall be set in accordance with engineer's instructions or as shown.
      - 10) Electrical Tests:
        - i) System neutral insulation resistance shall be measured to insure no shunt ground paths exist, neutral-ground disconnect link shall be removed, neutral insulation resistance measured and link replaced.
        - ii) The relay pickup current shall be determined by current injection at the sensor and the circuit interrupting device operated.
        - iii) The relay timing shall be tested by injecting 150% and 300% of pickup current into sensor. Total trip time shall be electrically monitored.
        - iv) System operation shall be tested at 57% rated voltage value.

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- v) Zone interlock system shall be tested by simultaneous sensor current injection and monitoring zone blocking function.
- 11) Test Parameters:
  - i) System neutral insulation resistance shall be two (2) mega-ohm or greater.
  - ii) Relay pickup current shall be within 10% of device dial of fixed setting.
  - iii) Relay timing shall be in accordance with manufacturer's published time-current characteristic curves.
- c) Transformers, dry type: Refer to section 26 22 13 "Low Voltage Distribution Transformers" for requirements.
- d) Motor Controllers: Refer to section 26 24 19 "Motor Control" for requirements.
- e) Switchboards: Refer to section 26 24 13 "Switchboards" for requirements. Perform thermographic survey (Infrared scanning) of all feeder (destination) breakers in accordance with NETA Section 9.
- f) Panelboards: Refer to section 26 24 16 "Panelboards" for requirements.
- g) Generator:
  - 1) Scope: Test generator and breakers. Refer to section 26 32 13 "Engine Generators" for additional requirements.
  - 2) Inspect generator, all major components and report installation or shipping damage, loose material, shipping blocks, contamination or unfavorable environmental conditions that must be corrected. Check equipment for operation of doors, security of mounting. Report any deficiencies.
- h) Automatic Transfer Switches:
  - 1) Scope: Test all new and existing transfer switches. Refer to section 26 3623 "Automatic Transformer Switches" for additional requirements.
  - 2) Inspect transfer switches and report installation or shipping damage, loose material, shipping blocks, contamination or unfavorable environmental conditions that must be corrected. Check equipment for operation of doors, security of mounting. Report any deficiencies.
- i) UPS:
  - 1) Scope: Test all UPSs and associated breakers. Coordinate with FPM Engineering for additional requirements.
  - 2) Inspect all UPSs, all major components, terminations and report installation or shipping damage, loose material, shipping blocks, contamination or unfavorable environmental conditions that must be corrected. Check equipment for operation of doors, security of mounting. Report any deficiencies.
- j) Metering Test & Calibration:
  - 1) Scope: Test all new meters provided by this contract.
  - 2) Instrument Transformers:
    - i) Test transformer polarity electrically.
    - ii) Verify connection at secondary CT leads by driving a low current through the leads and checking for this amount at applicable devices.
    - iii) Confirm transformer ratio by primary current injection.
    - iv) Measure insulation resistance primary-to-ground, secondary-to-ground and primary-to-secondary.

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- v) Overpotential test primary insulation.
- vi) Measure potential transformer ratio.
- 3) Metering and instrumentation
  - i) aa Calibrate all meters at mid-scale.
  - ii) Calibrate watt hour meter to one-half percent.
  - iii) Verify all instrument multipliers.
- 2. Test to be performed by contractor:
  - a) Receptacle and device tests
    - 1) Receptacle Polarity Test: Test every receptacle installed or reconnected under this contract with a receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and re-test. Submit test report signed by the electrician that performed the test.
    - 2) Ground-Fault Receptacle Circuit Interrupter Tests: Test each receptacle or branch circuit breaker having ground-fault circuit protection to assure that the ground-fault circuit interrupter will not operate when subjected to a ground-fault current of less than 4 milliamperes and will operate when subjected to a ground-fault current exceeding 6 milliamperes. Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. Apply the test to the receptacle. A TEST@ button operation will not be acceptable as a substitute for this test. Replace receptacles that do not shut-off power with 5/1000 of an ampere with 1/40th of a second and re-test.
    - 3) Operational Tests: Demonstrate the operation of each switch, circuit breaker and other item of electrical control with the systems fully energized and operating. Each shall be demonstrated three (3) times.
  - b) 600 volt wiring
    - 1) Scope: Test all electrical feeders and conductors for motors over 15 hp whose operating voltage is 600 volts or less that are installed or re-connected under this contract.
    - 2) Test for continuity of each circuit.
    - 3) Test for grounds in each circuit which shall consist of the physical examination of the installation to ensure that all required ground jumpers, devices and appurtenances do exist and are mechanically firm.
    - 4) Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one (1) minute. If conductor fails test replace wiring or correct defect and re-test.
    - 5) Perform torque test for each conductor tested and terminated in an overcurrent device or bolted type connection; torque all connections per manufacturer's recommendations and tabulate the results on a tabular form.
    - 6) All feeders shall be Megger tested prior to energizing any equipment.
  - c) Power system tests
    - 1) Scope: Inspect and test entire electrical systems provided by this contract to verify equipment and controls are correctly operating.

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- 2) Load Balance Tests: Check all panelboards for proper load balance between phase conductors and make adjustments as necessary to bring unbalanced phases to within 15% of average load.
  - 3) Motor Tests: Prior to energizing any motors check all motors for proper rotation, phase balance and measure actual load current. Report immediately to the University's Representative if phase balance exceeds 1% from mean value. Submit tabulation of motor currents for all motors 1 HP or more after the HVAC system has been balanced.
  - 4) Phase Relationship Tests: Check connections to all new and existing equipment for proper phase relationship. During such check, disconnect all devices that could be damaged by the application of voltage or reversed phase sequence.
  - 5) Transformer Taps: Connect all transformers at A Normal tap. After facility is fully occupied for a period of not less than two weeks, measure secondary voltages at all new and existing transformers.
- d) Variable frequency drives
- 1) Physical Mechanical Inspection (Electrical Contractor)
    - i) Drive and motor environment clean.
    - ii) Adequate drive and motor access for ventilation and maintenance
    - iii) No unusual noise or vibration.
    - iv) No disconnects installed between VFD and motor w/o shutdown interlock to VFD.
    - v) Shut-down interlocks between VFD and motor verified to be operational.
    - vi) Separate conduit for incoming power and outgoing motor leads.
    - vii) No power factor correction capacitors connected to motor.
    - viii) Shaft rotation correct, normal operation
    - ix) If equipped with bypass, note bypass starter overload size for correct operation.
    - x) Shaft rotation correct for bypass operation.
    - xi) Verify bypass switch starts and operates equipment.
    - xii) Compare motor nameplate with VFD for compatibility.
    - xiii) Inspect structure frames, supports, barriers, doors, etc. for alignment and proper fit.
    - xiv) Inspect control wiring terminations, fuses, shielding, pull apart connectors and board engagement.
- e) Electrical Checks (Electrical Contractor)
- 1) Verify wiring conforms to factory schematics.
  - 2) Verify instrument transformer ratios match meter scales.
- f) Electrical Checks (Manufacturer's Representative)
- 1) Insure proper operation of:
    - i) Pilot devices (switches, pushbuttons, lights)
    - ii) Contactors and line voltage starters.
    - iii) Control and timing relays.
    - iv) Protective devices.
    - v) Auxiliary electrical contacts.
    - vi) Circuit breakers and disconnect switches.
  - 2) Perform other tests and startup procedures as recommended by manufacturer.

**USC DESIGN GUIDELINES**

**END OF DOCUMENT**

# USC BASIS OF DESIGN

## 26 0913 ELECTRICAL POWER MONITORING AND CONTROL

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to electrical power monitoring specifically related to electrical equipment and the University's EBI (Enterprise Building Integrator) building management system.
  - 2. Preferred: None
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Communication Components
  - 1. Communications: The EBI has been licensed with the most commonly used interface options in the industry.
  - 2. Modbus TCP Connection
    - a) EBI supports the 584 and 984 Modbus controllers
    - b) EBI communicates with Modbus controllers by way of the Modbus TCP protocol
    - c) To connect Modbus controllers to the EBI using the Modbus TCP protocol, required to have network adapter (NA card) connected to an Ethernet network on both the Server and Controller sides.
  - 3. Lon / IP
    - a) LonWorks point server enabled to directly connect to LON devices
    - b) Supports the ability to read and write NVs and CPs
  - 4. BACnet / IP Direct Client Interface
    - a) BBMD (BACnet Broadcast Management Device) required due to multiple network subnets
    - b) Uses point server technology

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- c) Natively supports all the BACnet object types and standard and optional properties
- 5. OPC (OLE for Process Control)
  - a) COM interfaces based on Microsoft's COM/OLE technology

### B. EQUIPMENT REQUIREMENTS

- 1. For equipment that communicates via RS422/485 or Modbus RTU serial communications
  - a) Provide additional gateway – Lantronix UDS1100 or equal
  - b) Provide network drop at gateway location
  - c) Submit completed Device Registration Form to Facilities Management Services – Energy Services
- 2. For equipment that communicates via LonWorks
  - a) Device may require additional equipment depending on the LON infrastructure of the Building
  - b) If no LON infrastructure exists, provide additional router – Loytec LIP-33ECTB or equal
  - c) Provide network drop at router location
  - d) Submit completed Device Registration Form to Facilities Management Services – Energy Services
- 3. For equipment that communicates via BACNet
  - a) Provide additional router – Loytec LIP-ME201 or equal
  - b) Provide network drop at router location
  - c) Submit completed Device Registration Form to Facilities Management Services – Energy Services
- 4. For equipment that communicates via BACNet Over IP
  - a) Provide network drop at equipment location
  - b) Submit completed Device Registration Form to Facilities Management Services – Energy Services
- 5. For equipment that uses a router/firewall with multiple IP addresses, need to configure router for only one IP. USC network will not allow a single device with multiple IP addresses to sit on the network. Refer to Div 27.

### C. MONITORED POINTS REQUIREMENTS

- 1. Automatic Transfer Switches
  - a) Source Position (Normal or Emergency)
  - b) For ATS with bypass isolation, include Bypass Switch Position
- 2. Generators
  - a) “Not in Auto”
  - b) Generator Running Alarm
  - c) Low Fuel Alarm
  - d) General Trouble Alarm



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### 4. INSTALLATION REQUIREMENTS

#### A. INSTALLATION

1. Install all devices according to manufacturer's specifications
2. Identify cables according to Section 26 05 53 "Identification for Electrical Systems."

#### B. FIELD QUALITY CONTROL

1. Testing: [Owner will engage] [Engage] a qualified testing and inspecting agency to perform field tests and inspections.
2. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

#### C. Test and Inspections:

1. Electrical Tests: Use caution when testing devices containing solid-state components.
2. Continuity tests of circuits
3. Operational Tests: Set and operate controls at workstation and at monitored devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central- processing workstation.
4. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored, [including] [26 3623 Automatic Transfer Switches] [26 3213 Engine Generator] [26 2713 Electricity Metering] [other-specify]

D. Power monitoring equipment will be considered defective if it does not pass tests and inspections.

E. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

F. Remove and replace malfunctioning units and retest as specified above.

## **USC BASIS OF DESIGN**

G. Preferred: None

H. Disallowed: None

### **5. EVALUATION or COMMISSIONING**

A. No Requirements

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 0936 MODULAR DIMMING CONTROLS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document for new and existing Modular Dimming Controls systems.
- B. For additions or modifications to existing systems, plans shall be approved by FPM Energy Services
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purposes of this guideline, this section pertains to new Modular Dimming Controls system for local dimming of classrooms, lecture halls and auditoriums.
      - 1) New systems for lecture halls and auditoriums shall be controlled by a Modular Dimming Control system
        - i) Acuity Controls "Fresco" or equal.
      - 2) New systems for classrooms shall be controlled by a local dimming controller:
        - ii) Acuity Controls "nLIGHT" or equal.
      - 3) Modifications or additions to any existing system shall be approved at the design phase by FPM Energy Services.
      - 3) Modifications or additions to existing systems shall match the existing manufacturer.
    - b) Systems shall consist of factory assembled dimming controls, low voltage wall stations, control interfaces and modules, occupancy (motion) sensors, and LED lighting fixtures. Additional components may also be required and are described herein and/or shown on the drawings.
    - c) The system must be designed and installed to comply with all code requirements required by Title 24 of the State of California, based on the design date.
  - 2. Preferred:
    - a) None.

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3. Disallowed:
  - a) None.
- B. Quality Assurance requirements beyond a standard one (1) year warranty:
  1. The Modular Dimming Control systems shall be listed and comply as required with all federal, state and local energy codes to include, but not be limited to California Title 24, ASHRAE 90.1-2004 and the City of Los Angeles.
  2. Provide equipment complying with FCC emissions' standards, part 15, subpart J for Class A applications.

### 3. PRODUCT REQUIREMENTS

- A. Modular Dimming Systems:
  1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred for New Systems:
      - 1) Acuity Controls, "Fresco, nLIGHT"
      - 2) Or equal
    - b) Preferred for existing system modifications or additions:
      - 1) Match existing manufacturer
    - d) Disallowed: Lightolier Dimming.
  2. Component Characteristics:
    - a) Required:
      - 1) Dimming Performance Requirements:
        - i) Electrolytic capacitors operate at least 36 degrees F (20 degrees C) below the capacitor's maximum temperature rating when the device is under full load
        - ii) Inrush tolerance: Use MOSFET that has a maximum rating of six times the operating current of the dimmer/relay
        - iii) Surge tolerance: Panels are designed and tested to withstand surges of 6,000V, 3,000amps according to IEEE C62.41.2 and IEC 61000-4-5 without impairment to performance
        - iv) Power failure recovery: When power is interrupted and subsequently restored, within 3 seconds lighting to automatically return to same levels prior to power failure
        - v) Utilize half cycle to half cycle zero cross movement to allow for voltage compensation in order to overcome line noise and lamp flickering
        - vi) Incorporate electronic soft start default at initial turn-on that smoothly ramps lights to appropriate levels within 0.5 seconds
        - vii) Utilize air gap off to disconnect the load line from the line supply
        - viii) Control all light sources in smooth and continuous manner. Dimmers with visible steps are not acceptable
        - ix) Assign load type to each dimmer that will provide proper dimming curve for the specific light source to be controlled
        - x) Minimum and maximum light levels are user adjustable on a circuit by circuit basis

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- 2) Power Interfaces:
    - i) Small rooms: Power pack(s) shall be provided depending on the load types to be controlled.
    - ii) Larger rooms: Provide dimming panels as required due to number of circuits to be dimmed.
  - 3) Multi-zone wall station (Acuity Controls Fresco or equal):
    - i) The number of zones shall be determined per plans.
    - ii) Intensity for each zone indicated by means of one graphically represented slider.
    - iii) Fade time selectable for each scene.
    - v) For temporary local overrides, individual raise/lower buttons to allow zones to be adjusted without altering scene values stored in memory.
  - 4) Low voltage wall station (Acuity Controls, nLight Series or equal)
    - i) Electronic switch with preset buttons and LEDs.
    - ii) The switch shall be capable of easy reprogramming without replacing unit.
    - iii) Engrave wall stations with appropriate button, zone and scene engraving descriptions furnished prior to fabrication.
    - iv) Provide faceplates with concealed mounting hardware.
  - 5) Low voltage Control Interfaces:
    - i) Provide Contact Closure Interfaces as required to integrate the lighting controls with other systems (i.e. A/V, shades, etc.).
    - ii) Provide interfaces to communicate directly with dimming control station via user-supplied PC or digital audiovisual equipment.
    - iii) Provide programmable interface to Astronomical time clock.
    - iv) Provide ability to communicate via Ethernet to dimming control station via user-supplied PC.
  - 6) Sensors:
    - i) Interior Daylight Sensors: Closed-loop basis for daylight sensor control scheme.
    - ii) Partition Sensor: Provide contact closure based on status of sensor.
    - iii) Occupancy Sensor: Provide dual technology PIR and Microphonics
      - b) Preferred: Acuity Brands nLight
      - c) Disallowed: None
- B. Local Lighting Controllers:
1. Manufacturers: Acuity Controls, "nLight" series or equal
  2. Component Characteristics:
    - a) Required:
      1. Power pack will incorporate one or more Class 1 relays and

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contribute low voltage power to the rest of the system

2. Secondary power packs incorporate the relay(s), 0-10VDC dimming output, or line voltage dimming output
3. Accept 120/277VAC and plenum rated
4. All devices have two RJ-45 ports
5. Parameters available and configurable remotely from software and locally via device push-button
6. Power pack to be securely mounted to junction box with ½ inch threaded chase nipple or mounted within luminaire ballast channel
7. Power (secondary) packs that provide up to 16A switching of all load types
8. Power (secondary) packs that provide up to 5A switching of all load types as well as 0-10VDC dimming or fluorescent ballasts/LED drivers
9. Specific secondary packs provide up to 5A of switching and can dim 120VAC incandescent or 120/277VAC line voltage dimmable fluorescent (2-wire and 3-wire versions)
10. Specific secondary packs provide up to 5A of switching and can dim 120/277VAC magnetic low voltage transformers
11. Specific secondary packs provide up to 5A of switching and can dim 120VAC electronic low voltage
12. Specific power/secondary are UL924 listed for switching of emergency power circuits

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. The Dimming Control system equipment shall be installed in accordance with manufacturer's recommendations and as required on contract documents.
2. The Dimming Control system shall be installed utilizing manufacturer's approved shop drawings and in accordance with these specifications.
3. The entire system shall be installed per applicable requirements of the CEC, California Energy Commission.
4. Coordinate all conduit terminations for line voltage and low voltage conductors.
5. Low voltage and line voltage wiring shall not be run together in the same conduit.
6. The contractor shall be required to provide input feed wiring, load wiring and control wiring which terminates to a set of clearly marked low voltage terminals.
7. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.
8. Define each dimmer's load type, assign each load to a zone and set control functions
9. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaries.
10. Contractor shall assign the system transmitters for each room to the appropriate controller to configure the room.
11. Install wall mounted devices with the vertical centerline plumb and flush against adjacent wall surfaces.

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- B. Preferred: None
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Central Dimming Controls system.
- B. Documentation required:
  - 1. Test reports: The contractor shall hire factory trained technicians to functionally test each system component after installation to verify proper operation of the entire system, including all dimmers, dimming stations, switches, sensors and etc. and provide reports for all connections/terminations, controls and settings.
- C. Required testing protocols:
  - 1. Upon completion of the installation contractor shall completely test all line voltage power and low voltage control wiring for continuity and accuracy of connections.
  - 2. Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
    - a) Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
  - 3. System Start-up Training:
    - a) The manufacturer shall be notified 14 days in advance prior to substantial completion of the project to run a final diagnostics and confirm system programming.
    - b) A factory technician shall be provided for a one-day on-site training of the University's representatives and maintenance personnel.
  - 4. Replace at no additional costs to the University all devices or components, which are found defective or do not operate within factory specified tolerances.
  - 5. Submit the testing final report for review prior to project closeout and final acceptance by the University's Representative. Test report shall indicate test dates, devices tested, results, observation, deficiencies and remedies. Test report shall be included in the operation and maintenance manuals.
- D. Quality Assurance requirements beyond standard 1 year warranty:
  - 1. The lighting control system shall be listed, approved and comply as required with all national, state and local energy codes to include but not limited to California Title 24 and ASHRAE 90.1-2004.
  - 2. All materials, equipment and parts comprising the units specified herein shall be manufactured recently and of current manufacturer.
  - 3. All materials, equipment, accessories and devices covered by these specifications shall be complete and best suited for the intended use and shall conform to applicable codes and standards for their use.
  - 4. Provide equipment complying with FCC emissions' standards in part 15 subpart J for Class A application.
  - 5. Warranty: Five (5) year 100% parts replacement
  - 6. Provide a spreadsheet of all components and associated distributor(s)

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## 5. EXHIBITS



Device	Label	Labeling Sequence	Labeling Example
<b>Power Relay Packs</b>			
nPP16	PP	Rm#/Switchleg/PP/Serial#	101 APP 123456
nPP16ER	PPER	Rm#/Switchleg/PPER/Serial#	101 APPER 123456
nPP16D	PPD	Rm#/Switchleg/PP/ Serial#	101 APPD 123456
nPP16DER	PPDER	Rm#/Switchleg/PPDER/Serial#	101 APPDER 123456
nPANEL4	NP4	Rm#/Switchleg/NP4/Serial#	101 A/B NP4 123456
Daylight Harvesting: Daylight Zone 1 (DZ1)/ Daylight Zone 2 (DZ2)			101 APPDZ1 123456
<b>Secondary Relay Packs</b>			
nSP5 PCD 2W	2W	Rm#/Switchleg/2W/Serial#	101 A2W 123456
nSP5 PCD MLV	MLV	Rm#/Switchleg/MLV/Serial#	101 AMLV 123456
nSP5 PCD ELV 120	ELV	Rm#/Switchleg/ELV/Serial#	101 AELV 123456
nSP5 PCD 3W	3W	Rm#/Switchleg/3W/Serial#	101 A3W 123456
Daylight Harvesting: Daylight Zone 1 (DZ1)/ Daylight Zone 2 (DZ2)			101 A2WDZ1 123456
<b>nLight Enabled Fixtures</b>			
NEF 2x2 & 2x4 Fixtures	NEF	Rm#/Switchleg/NEF/Serial#	101 ANEF 123456
NEF Can Lights (nPS80EZ)	NEFEZ	Rm#/Switchleg/NEFEZ/Serial#	101 ANEFEZ 123456
Daylight Harvesting: Daylight Zone 1 (DZ1)/ Daylight Zone 2 (DZ2)			101 ANEFDZ1 123456
<b>Wall Switches (WallPods)</b>			
nPODM DX	WS1P	Rm#/WS1P/Serial#	101 WS1P 123456
nPODM 2P DX	WS2P	Rm#/WS2P/Serial#	101 WS2P 123456
nPODM 4P DX	WS4P	Rm#/WS4P/Serial#	101 WS4P 123456
nPODM GFX	WSGFX	Rm#/WSGFX/Serial#	101 WSGFX 123456
nWSX (PDT)LV DX	WSOS	Rm#/WSOS/Serial#	101 WSOS 123456
nPODM 1S	WS1S	Rm#/WS1S/Serial#	101 WS1S 123456
nPODM 2S	WS2S	Rm#/WS2S/Serial#	101 WS2S 123456
nPODM 4S	WS4S	Rm#/WS4S/Serial#	101 WS4S 123456
<b>Occupancy and Daylight Harvesting Sensors</b>			
nCM/RM 9 RJB	OS	Rm#/OS/Serial#	101 OS 123456
nCM/RM 10 RJB	OS	Rm#/OS/Serial#	101 OS 123456
nCM/RM PDT9 RJB	OS	Rm#/OS/Serial#	101 OS 123456
nCM/RM PDT10 RJB	OS	Rm#/OS/Serial#	101 OS 123456
nCM/RM ADCX RJB	PC	Rm#/PC/Serial#	101 PC 123456
nCM/RM PDT 9 ADCX RJB	OSPC	Rm#/OSPC/Serial#	101 OSPC 123456
nCM/RM PDT 10 ADCX RJB	OSPC	Rm#/OSPC/Serial#	101 OSPC 123456
nCM/RM 6 RJB	OS6	Rm#/OS6/Serial#	101 OS6 123456
nWV (PDT) 16	WV16	Rm#/WV16/Serial#	101 WV16 123456
<b>Backbone Device</b>			
nBRG 8	BRG	BRG#/123456	BRG01 123456

# USC DESIGN GUIDELINES

END OF DOCUMENT

# USC DESIGN GUIDELINES

## 26 0943 NETWORK LIGHTING CONTROLS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X			X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to Network Lighting Controls system that has capability to communicate seamlessly with the Campus Central Lighting Control system so it can be remotely controlled via the internet or building wide Ethernet LAN by FPM Facilities
      - 1) Integration of the lighting control software (sensorview) with the building services must be coordinated with FPM Energy Services
      - 2) Manufacturers start up technicians must provide the following services prior to conclusion of the project through collaboration with FPM Energy Services:
        - i) Program all controls according to USC standard specifications
        - ii) Oversee the connection of the BMS connection to BACNET points.
        - iii) Assist in the setup of software plug-ins including Green Screen and Virtual Wall Pods as required.
        - iv) Set up group scheduling
        - v) Provide task tuning.
    - b) Provide network lighting control system consisting of components manufactured by single source. The lighting control system shall consist of but not limited to:
      - 1) Digital network lighting control system shall be computer-based software that provides control, configuration, monitoring, alerting and reports.
      - 2) The lighting control system shall provide time-based, sensor-based (Both occupancy and daylight), and manual lighting control.
      - 3) The system shall be capable of turning lighting loads on/off as well as dimming lights.
      - 4) All system devices shall be networked together enabling digital communication and shall be individually addressable.

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- 5) The system architecture shall can enable stand-alone groups (rooms) of devices to function in some default capacity even if network connectivity to the greater system is lost.
  - 6) The system architecture shall facilitate remote operation via computer connections.
  - 7) The system shall not require any centrally hardwired switching equipment.
  - 8) The system shall be capable of wireless, wired, or hybrid wireless/wired architectures.
  - 9) The system shall be capable of warning of an impending off sweep by flashing lights Off/On once or twice (programmable) by relay or by zone prior to the lights being turned off. Building occupants shall be able to override any scheduled "Off" sweep using dedicated wall switches within the occupied space for a short period of time (programmable) that does not exceed 2-hours, prescribed by California Energy Commission.
  - 10) The system shall be capable of implementing on commands, Off commands, Raise (dimming) commands, Lower (dimming) commands for any relay, group or zone by means of digital wall switches, contact closure switches, time clock schedules including offsets from dusk and dawn by up to 10 hours, photocell, pc software or other devices connected to programmable inputs in a lighting control panel.
  - 11) The Network Lighting Control system installed shall have minimum of 20% spare capacity to accommodate future growth or revisions.
  - 12) System design and BOM shall include additional 1% of all devices for stock in hand. To be provided by the installing contactor to USC.
  - 13) The system must be designed and installed to comply with all code requirements required by title 24 for the state of California based on the design date.
2. Preferred:
    - a) Acuity Brands: nLight
  3. Disallowed:
    - a) None
- B. Quality Assurance requirements beyond standard 1 year warranty:
1. The lighting control system shall be listed, approved and comply as required with all national, state and local energy codes to include but not limited to California Title 24 and ASHRAE 90.1-2004.
  2. All materials, equipment and parts comprising the units specified herein shall be manufactured recently and of current manufacturer.
  3. All materials, equipment, accessories and devices covered by these specifications shall be complete and best suited for the intended use and shall conform to applicable codes and standards for their use.
  4. Provide equipment complying with FCC emissions' standards in part 15 subpart J for Class A application.
  5. Warranty: Five (5) year 100% parts replacement
  6. Provide a complete spreadsheet of all components and associated distributor(s)

### C. System Characteristics:

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1. System shall have an architecture that is based upon three main concepts: 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.
2. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.
3. System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see *Networked LED Luminaire* section).
4. Intelligent lighting control devices shall communicate digitally, require <7 mA of current to function (Graphic wall stations excluded), and possess RJ-45 style connectors.
5. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher-level network backbone.
6. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.
7. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
8. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.
9. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, controls enabled luminaires, or from the network backbone. Standalone “bus power supplies” shall not be required in all cases.
10. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e., not in remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.
11. System shall have one or more primary wall mounted network control “controller” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.
12. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.
13. System shall be capable of wirelessly connecting a lighting zone to a wireless data network for purposes of eliminating the “bridge” devices and all cabling that connects zones to bridge devices.
14. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control schedules and profiles.
15. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.
16. Devices located in different lighting zones shall be able to communicate occupancy, photocell (non-dimming), and switch information via either the wired or wireless backbone.
17. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of

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operation according to a time schedule so as to enable customized time-of-day, day-of-week, utilization of a space. Note: Operating modes should be utilized only in manners consistent with local energy codes.

- D. Switching Schemes:
1. Auto-On | Auto-Off (via occupancy sensors)
    - a) Zones with occupancy sensors automatically turn lights on when occupant is detected.
    - b) Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
    - c) Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again, restoring the sensor to Automatic On functionality.
  2. Manual-On | Auto-Off (also called Semi-Automatic)
    - a) Pushing a switch will turn lights on.
    - b) Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
  3. Manual-On to Auto-On/Auto-Off
    - a) Pushing a switch will turn lights on.
    - b) After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.
    - c) Sequence can be reset via scheduled (ex. daily each morning) events
  4. Auto-to-Override On
    - a) Zones with occupancy sensors automatically turn lights on when occupant is detected.
    - b) Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
    - c) Sequence can be reset via scheduled (ex. daily each morning) events
  5. Manual-to-Override On
    - a) Pushing a switch will turn lights on.
    - b) Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.
    - c) Sequence can be reset via scheduled (ex. daily each morning) events
  6. Auto On | Predictive Off
    - a) Zones with occupancy sensors automatically turn lights on when occupant is detected.
    - b) Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.
    - c) If switch is pressed, lights turn off and a short "exit timer" begins. After timer expires, sensor scans the room to detect whether occupant is still present. If no occupancy is detected, zone returns to auto-on. If occupancy is detected, lights must be turned on via the switch.
  7. Multi-Level Operation (multiple lighting levels per manual button press)
    - a) Operating mode designed specifically for bi-level applications
    - b) Enables the user to cycle through the up to four potentials on/off lighting states using only a single button.
    - c) Eliminates user confusion as to which of two buttons controls which load
  8. Three different transition sequences are available in order to comply with energy codes or user preference)
    - a) Mode available as a setting on all light devices that have single manual

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- on/off switch (ex. nWSX, nPODM, nPODM-DX).
- b) Depending on the sequence selected, every button push steps through relays states according to below table
  - c) In addition to achieving bi-level lighting control by switching loads with relays, the ability to command dimming outputs to "step" in a sequence that achieves bi-level operation is present.

### 3. PRODUCT REQUIREMENTS

#### A. Manufacturer:

1. Required for New Buildings and complete renovations:
  - a) Acuity Brands nLight
2. Acceptable for tenant improvement and limited renovations
  - a) Acuity Brands nLight and nLight Air
  - b) Enlighted
  - c) Daintree

#### B. CONTROL MODULE (ECLYPSE CONTROLLER)

1. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet network.
2. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.
3. Control device shall have three RJ-45 ports for connection to the graphic touch screen, other backbone devices bridges) or directly to lighting control devices (up to 128 per port).
4. Device shall automatically detect all devices downstream of it.
5. Device shall have a standard and astronomical internal time clock.
6. Device shall have one RJ-45 10/100 BaseT Ethernet connection.
7. Device shall have a USB port
8. Each control gateway device shall be capable of linking 1500 devices to the management software.
9. Device shall be capable of using a dedicated static or DHCP assigned IP address.
10. BACnet Testing Laboratories (BTL) listed as a BACnet Building Controller (B-BC)
11. Network Control device shall be the following nLight model Series: **nECY 120 BAC**

#### C. NETWORKED SYSTEM OCCUPANCY SENSORS

1. General:
  - a) Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
  - b) Sensors shall utilize passive infrared {PIR} technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
  - c) For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional "dual" technology shall be used.
  - d) Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes

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PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion {PIR/Ultrasonic) shall not be acceptable.

- e) All sensing technologies shall be acoustically passive meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
- f) Sensors shall be available with zero, one, or two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120 I 277 I 347 VAC. Load ratings shall be 800 W@ 120 VAC, 1200 W@ 277 VAC, 1500 W@ 347 VAC, and X HP motor. Relays shall be dry contacts.
- g) Sensors shall be available with one or two occupancy "poles", each of which provides a programmable time delay.
- h) Sensors shall be available in multiple lens options which are customized for specific applications.
- i) Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-S low voltage cabling with RJ-45 connectors.
- j) All sensors shall have two RJ-45 ports or capable of utilizing a splitter.
- k) All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-S connections) and blink its LED in a pattern to visually indicate of a potential wiring issue
- l) Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
- m) Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
- n) Sensors shall be equipped with an automatic override for 100-hour burn-in of lamps. This feature must be available at any time for lamp replacements.
- m) Sensors shall comply with Title 24 requirements by automatically turning on lighting at 70%.

### D. WALL SWITCH SENSOR:

- 1. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.
- 2. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.
- 3. Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.
- 4. Wall switch sensors shall be White or as directed by Architect.
- 5. Wall switch sensors shall be available with optional raise/lower dimming adjustment controls.
- 6. Sensors shall comply with Title 24 requirements by automatically turning on lighting at 70%.
- 7. Wall switch sensors shall be the following Sensor Switch model numbers, with device color and optional features as specified:



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- a) nWSX LV (PIR, No Relay, Raise/Lower Dim Ctrl)
- b) nWSX PDT LV (Dual Tech w/ Night light, No Relay, Raise/Lower Dim Ctrl)

### E. EMBEDDED SENSORS:

1. 1. Network system shall have sensors that can be embedded into luminaire such that only the lens shows on luminaire face.
2. Embedded sensors shall be capable of both PIR and Dual Technology occupancy detection
3. Embedded sensors shall have an optional photocell
4. Embedded sensors shall be the following Sensor Switch model number:
  - a) nES 7 (PIR, No Relay)
  - b) nES 7 ADCX (PIR w/ Photocell, No Relay)
  - c) nES PDT 7 {Dual Technology, No Relay}
  - d) nES PDT 7 ADCX (Dual Technology w/ Photocell, No Relay)
5. Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.
6. Fixture mount sensors shall be capable of powering themselves via a line power feed.
7. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.
8. Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current (typically 40 or more ballasts).
9. System shall have wireless enabled fixture mountable sensors available
10. Wireless enable sensors shall be one of the Sensor Switch model numbers:
  - a) RES7N (networked)
  - b) RES7Z (stand-alone zone).

### F. NETWORKED SYSTEM DAYLIGHTSENSORS

1. Photocell shall provide for an on/off set-point, and a dead band to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
2. Photocell and dimming sensor's set-point and deadband shall be automatically calibrated through the sensor's microprocessor by initiating an "Automatic Set-point Programming" procedure. Min and max dim settings as well as set-point may be manually entered.
3. Dead band setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
4. Dimming sensors shall control 0 to 10 VDC dimmable ballasts by sinking up to 20mA of class 2 current (typically 40 or more ballasts).
5. Photocell and dimming sensors shall be equipped with an automatic override for 100-hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the "auto set-point" setting.)
6. Combination units that have all features of on/off photocell and dimming sensors shall also be available.
7. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The second zone shall be capable of being controlled as an "offset" from the primary zone.
8. Line voltage versions of the above described photocell and combination photocell/dimming sensors shall be capable of switching both 120 VAC, 277 VAC, and 347 VAC. Load ratings shall be 800 W@ 120 VAC, 1200 W@ 277

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VAC, 1500 W@ 347 VAC, and Y.4 HP motor load. Relays shall be dry contacts.

9. Sensor shall be the following Sensor Switch model numbers, with device options as specified:
  - a) nCM ADC (dimming)
  - b) nCM PC ADC (on/off, 0-10 VDC dimming)
10. Network system shall have dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
11. Embedded sensors shall be the following Sensor Switch model number: nES ADCX (Dimming Photocell)

### G. NETWORKED SYSTEM POWER (RELAY) PACKS

1. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
  - a) Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
  - b) All devices shall have two RJ-45 ports.
  - c) Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
  - d) Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or IndustrialControl Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
  - e) When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
  - f) Power Packs and Power Supplies shall be available that are wireless enabled.
  - g) Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all lighting load types.
  - h) Power (Secondary) Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.
  - i) Specific Secondary Packs shall be available that provide up to 5 Amps of switching as well as 0-10 VDC dimming of fluorescent ballasts/LED drivers.
  - j) Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
  - k) Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
  - l) Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
  - m) Specific Secondary Packs shall be available that provide up to 5 Amps of

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- switching of dual phase (208/240/480 VAC) lighting loads.
- n) Specific Secondary Packs shall be available that require a manual switch signal (via a networked Wall Station) in order to close its relay.
  - o) Specific Power/Secondary Packs shall be available that are UL9241 listed for switching of Emergency Power circuits.
  - p) Specific Secondary Packs shall be available that control louver/damper motors for skylights.
  - q) Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
- H. Power (Relay) Packs and Supplies shall be the following Sensor Switch model Series:
- 1. nPP16 (Power Pack w/ 16A relay)
  - 2. nPP16 D (Power Pack w/ 16A relay and 0-10VDC dimming output)
  - 3. nSP16 (Secondary Pack w/ 16A relay)
  - 4. nPP16 ER (UL924 Listed Secondary Pack w/16A relay for switching emergency power circuits)
  - 5. nPP16 D ER (UL924 Listed Secondary Pack w/ 16A relay and 0-10VDC dimming output for switching emergency power circuits)
  - 6. nSPS PCD 2W (Secondary Pack w/ SA relay and incandescent dimming or 2-wire line voltage fluorescent dimming output)
  - 7. nSPS PCD 3W (Secondary Pack w/ SA relay and 3-wire line voltage fluorescent dimming output)
  - 8. nSPS PCD MLV (Secondary Pack w/ SA relay and magnetic low voltage dimming output)
  - 9. nSPS PCD ELV 120 (Secondary Pack w/ 4A relay and electronic low voltage dimming output)
  - 10. nSHADE (Pulse On/Off Control Pack)
  - 11. nPS 80 (Auxiliary Bus Power Supply)
  - 12. nAR 40 (Low voltage auxiliary relay pack)
- I. NETWORKED SYSTEM RELAY AND DIMMING PANELS
- 1. Panel shall incorporate up to 4 normally closed latching relays capable of switching 120/277 VAC or up to 2 Dual Phase relays capable of switching 208/240/480 VAC loads.
    - a) Relays shall be rated to switch up to a 30A ballast load at 277 VAC.
    - b) Panel shall provide one 0-10VDC dimming output paired with each relay.
    - c) Panel shall power itself from an integrated 120/277 VAC supply.
    - d) Panel shall be capable of operating as either two networked devices or as one.
    - e) Panel shall supply current limited low voltage power to other networked devices connected via CAT-S.
    - f) Panel shall provide auxiliary low voltage device power connected wired directly to a dedicated terminal connection
  - 2. Power (Relay) Packs and Supplies shall be the following Sensor Switch model numbers:
    - a) nPANEL 4 (Panel w/ four 120/277 VAC relays and four 0-10 VDC dimming outputs)
    - b) nPANEL 2 480 (Panel w/ two dual phase relays (208/240/480 VAC) and two 0-10 VDC dimming outputs)
- J. NETWORKED AUXILIARY INPUT/ OUTPUT (I/O) DEVICES
- 1. Devices:
    - a) Devices shall be plenum rated and be inline wired, screw mountable, or

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- have an extended chase nipple for mounting to a W' knockout.
  - b) Devices shall have two RJ-45 ports
  - c) Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
  - d) Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current (typically, 40 or more ballasts).
  - e) Specific I/O devices shall have an input that read a 0-10 VDC signal from an external device.
  - f) Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event, run a local/remote control profile, or raise/lower a dimming output
  - g) Specific I/O devices shall sense state of low voltage outdoor photocells
  - h) Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.
  - i) Specific I/O devices shall sense
2. Auxiliary Input/Output Devices shall be the following Sensor Switch model numbers:
- a) nIO D (I/O device with 0-10 dimming output)
  - b) nIO 1S or nIO RLX (I/O device with contact closure or 0-10VDC dimming input)
  - c) nIO NLI (Input device for detecting state of low voltage outdoor photocell. sold in nIO PC KIT only)
  - d) nIO X (Interface device for communicating with RS-232 enabled AV Touch Screens)
- K. NETWORKED LED LUMINAIRES
1. Networked LED luminaires:
- a) Luminaires shall have a mechanically integrated control device
  - b) Luminaire shall have two RJ-45 ports
  - c) Luminaire shall be able to digitally network directly to other network control devices (sensors, photocells, switches, dimmers)
  - d) Luminaire shall provide low voltage power to other networked control devices
2. System:
- a) System shall be able to turn on/off LED luminaire without using a relay
  - b) System shall be able to maintain constant lumen output over the specified life of the LED luminaire (also called lumen compensation) by varying the input control power (and thus saving up to 20% power usage).
  - c) System shall indicate (via a blink warning) when the LED luminaire has reached its expected life (in hours).
3. LED luminaires shall be the following Lithonia model families or equal:
- a) Lithonia
  - b) Gotham
  - c) Peerless
  - d) Mark
- L. NETWORKED SYSTEM WALL SWITCHES & DIMMERS
1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
2. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

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3. All devices shall have two RJ-45 ports.
4. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
5. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
6. Devices with mechanical pushbuttons shall provide tactile and LED user feedback.
7. Devices with mechanical pushbuttons shall be made available with custom button labeling
8. Devices with a single "on" button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.
9. Wall switches & dimmers shall be the following nLight model numbers, with device options as specified:
  - nPODM** (single on/off, pushbuttons, LED user feedback)
  - nPODM DX** (single on/off, single dimming raise/lower, pushbuttons, LED user feedback)
  - nPODM 2P** (dual on/off, pushbuttons, LED user feedback)
  - nPODM 2P DX** (dual on/off, dual dimming raise/lower, pushbuttons, LED user feedback)
  - nPODM 4P** (quad on/off, pushbuttons, LED user feedback)
  - nPODM 4P DX** (quad on/off, quad dimming raise-lower, pushbuttons, LED user feedback)

### M. NETWORKED SYSTEM GRAPHIC WALL STATION

1. Product:
  - a) Device shall have a 3.5" full color touch screen for selecting up to 8 programmable lighting control presets or acting as up to 16 on/off/dim control switched.
  - b) Device shall enable configuration of lighting presets, switched, and dimmers via password protected setup screens.
  - c) Device shall enable user supplied .jpg screen saver image to be uploaded.
  - d) Device shall surface mount to single-gang switch box
  - e) Device shall have a micro-USB style connector for local computer connectivity.
  - f) Device shall have two RJ-45 ports for communication
2. Device shall be the following Sensor Switch model number: nPOD GFX

### N. NETWORKED SYSTEM SCENE CONTROLLERS

1. Controllers:
  - a) Device shall have two to four buttons for selecting programmable lighting control profiles or acting as on/off switches.
  - b) Device shall recess into single-gang switch box and fit a standard GFI opening.
  - c) Devices shall provide LED user feedback.
  - d) Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-S low voltage cabling with RJ-45 connectors.
  - e) All sensors shall have two RJ-45 ports.
  - f) Device shall be capable of reprogramming other devices in its zone to implement user selected lighting scene.

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- g) Device shall be capable of selecting a lighting profile be run by the system's upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
- h) Device shall have LEOs indicating current selection.
- 2. Scene Selector device shall be the following Sensor Switch model number:
  - a) nPODM 2S (2 Scene, push-button)
  - b) nPODM 4S (4 Scene, push-button)
  - c) nPODM 4S DX (4 Scene, push-button, On/Off/Raise/Lower)
  - d) nPODM 4L DX (4 Adjustable Presets, push-button, On/Off/Raise/Lower)

### O. COMMUNICATION BRIDGES

- 1. Product:
  - a) Device shall surface mount to a standard 4" x 4" square junction box.
  - b) Device shall have 8 RJ-45 ports.
  - c) Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.
  - d) Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-S cabled connection.
  - e) Device shall be careful of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.
- 2. Communication Bridge devices shall be the following Sensor Switch model numbers: nBRG 8 (8 Ports)

### P. LIGHTING CONTROL PROFILES

- 1. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.
- 2. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.
- 3. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profile.
- 4. Every device parameter (e.g., sensor time delay and photocell set-point) shall be configurable via a lighting control profile.
- 5. All lighting control profiles shall be stored on the network control gateway device and on the software's host server.
- 6. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset+/- timed offsets.
- 7. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.
- 8. Daylight savings time adjustments shall be capable of being performed automatically, if desired.
- 9. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.

### Q. MANAGEMENT SOFTWARE

- 1. Every device parameter (e.g., sensor time delay and photocell set point) shall be available and configurable remotely from the software
- 2. The following status monitoring information shall be made available from the

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software for all devices for which it is applicable: current occupancy status, current PIR Status, current Microphonics Status, remaining occupancy time delay(s), current photocell reading, current photocell inhibiting state, photocell transitions time remaining, current dim level, device temperature, and device relay state(s).

3. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.
4. A printable network inventory report shall be available via the software.
5. A printable report detailing all system profiles shall be available via the software.
6. Software shall require all users to login with a Username and Password.
7. Software shall provide at least three permission levels for users.
8. All sensitive stored information and privileged communication by the software shall be encrypted.
9. All device firmware and system software updates must be available for automatic download and installation via the internet.
10. Software shall be capable of managing systems interconnected via a WAN (wide area network)

### R. BMS COMPATIBILITY

1. BACnet Testing Laboratories (BTL) listed as a BACnet Building Controller (B-BC)
2. Native BACnet MS/TP and IP

### S. SYSTEM ENERGY ANALYSIS & REPORTING SOFTWARE

1. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.
2. Intuitive graphical screens shall be displayed to facilitate simple viewing of system energy performance.
3. An "Energy Scorecard" shall be display that shows calculated energy savings in dollars, KWHr, or C02.
4. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc.).
5. Energy savings data shall be calculated for the system as a whole or for individual zones.
6. A time scaled graph showing all relay transitions shall be presented.
7. A time scaled graph showing a zones occupancy time delay shall be presented
8. A time scaled graph showing the total light level shall be presented.
9. User shall be able to customize the baseline run-time hours for a space.
10. User shall be able to customize up to four time-of-day billing rates and schedules.
11. Data shall be made available via a .CSV file

## 4. INSTALLATION REQUIREMENTS

### A. EXAMINATION

1. Thoroughly examine site conditions for acceptance of lighting control system panels and components to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.

### B. INSTALLATION

1. Comply with requirements of Section 260500- Common Work Results for electrical.
2. Do not install network power controls until space is enclosed, HVAC systems are

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operating and overhead and wet work in space is complete.

3. Provide complete installation of system in accordance with Contract Documents.
4. Install network power switching controls in accordance with manufacturer's instructions.
5. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.
6. Grounding: Provide electrical grounding in accordance with NFPA 70.
7. Mount exterior daylight sensors to point due north with constant view of daylight.
8. Ensure that interior daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted, and fixture-mounted daylight sensors shall not have direct view of luminaires.
9. Ensure that occupancy sensor placement minimizes sensors view of areas beyond the control zone or outside the individual offices or rooms that are controlled by the sensor.
10. Provide all required components and programming to ensure the system is fully integrated with the equipment and systems specified in other Division 26 sections, A/V system, BAS system, shade controls and etc.
11. Provide panelboard schedule in pocket provided in panel doors.
12. System must comply with applicable Title 24 code requirements.

### C. SOFTWARE

1. A. Install and program software to meet the Owner's requirements. Provide current licenses. And backup copies of the software for the Owner's records.

### D. START-UP & SUPPORT FEATURES

1. Manufacturer's Field Service: Engage a factory-authorized service representative to assist in the start-up, including programming for the entire system.
  - a) To facilitate start-up, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.
  - b) All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.
  - c) Once software is installed, system shall be able to auto-discover all system devices without requiring any commissioning.
  - d) All system devices shall be capable of being given user defined names.
  - e) All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.
  - f) All sensor devices shall have the ability to detect improper communication wiring and blink it's LED in a specific cadence as to alert installation/startup personnel.

### E. TESTING

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections and operation of the entire system.
2. Switch each load on and off with manual line test feature of the power switching module before installing processors.
3. Perform operational testing to verify compliance with Specifications. Adjust as required.
  - a) Test for circuit continuity.
  - b) Verify that the control module features are operational.
  - c) Check operation of local override controls.



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- d) Test system diagnostics by simulating improper operation of several components selected by Architect.
- e) Prepare test and inspection reports.
- 4. Lighting controls will be considered defective if they do not pass tests and inspections.
  
- F. SEQUENCE OF OPERATION
  - 1. Building Wide as described or indicated on drawings.
  - 2. Area Functionality as described or indicated on drawings.
  
- G. FIELD QUALITY CONTROL
  - 1. Aim and Focus Visit: Owner's Representative to coordinate on-site meeting with Lighting Control System Manufacturer and Lighting Design Consultant to make required lighting adjustments to the system for conformance with the lighting Design Consultant's original design intent.
  
- H. ADJUSTING
  - 1. Within 12 months of the date of Substantial Completion provide on site service to adjust the system to account for actual occupied conditions.
  
- I. TRAINING
  - 1. Factory authorized service representative to instruct owner's staff to adjust, operate and maintain network power switching systems; and provide instruction using the system software.
  
- J. CLEANING
  - 1. Upon completion of project prior to final acceptance the contractor shall thoroughly clean the entire lighting control/management equipment. Remove paint splatters and other spots, dirt, and debris.
  
- K. PARTS LIST
  - 1. Provide a complete spare parts list, including recommended quantities and prices.
  
- L. CLOSEOUT ACTIVITIES
  - 1. Demonstration: Schedule a final demonstration with the Owner's Representative.
  - 2. Training: Train Owner's personnel to operate, maintain, and program network power switching systems. Allow for a minimum of trips to the jobsite to provide additional training as needed.
  - 3. Furnish set of approved submittals and record drawings of actual installation for owner's personnel in attendance at training session.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Network Lighting Controls system.
  
- B. Documentation required:
  - 1. Test reports: The contractor shall hire factory trained technicians to functionally test each system component after installation to verify proper operation of the entire system, including all relays, dimming units, switches, sensors etc. and provide reports for all connections/terminations, controls and settings.

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- C. Required testing protocols:
1. Test relays, switches, and sensors after installation to confirm proper operation and confirm correct loads are recorded on directory card in each panel.
  2. At least three weeks prior to any testing, notify the University's Representative so that arrangement can be made for witnessing test, if deemed necessary. All pre-testing shall have been tested satisfactorily prior to the University's Representative witnessed test.
- D. Pre-functional Testing:
1. Visual and Mechanical Inspection:
    - a) Inspect for physical damage, defects alignment and fit.
    - b) Perform mechanical operational tests in accordance with manufacturer's instructions.
    - c) Compare nameplate information and connections to Contract Documents.
    - d) Check tightness of all control and power connections.
    - e) Check that all covers, barriers and doors are secure.
  2. Electrical Tests:
    - a) The system shall be completely tested in accordance with operational parameters and manufacturer's instructions. Any problem shall be documented and corrected.
    - b) Submit a complete report listing every device, the date it was tested, the results and the date retested (if failure occurred during the previous test). The test report shall indicate that every device tested successfully.
  3. Start-up Testing and Training:
    - a) The manufacturer shall be notified 14 days in advance prior to substantial completion of the project to run a final diagnostics and confirm system programming on site or remotely.
    - b) A factory technician shall be provided for a one-day on-site training of the University's representatives and maintenance personnel.
  4. Replace at no additional costs to the University all devices, which are found defective or do not operate within factory specified tolerances.
  5. Submit the testing final report for review prior to project closeout and final acceptance by the University's Representative. Test report shall indicate test dates, devices tested, results, observation, deficiencies and remedies. Test report shall be included in the operation and maintenance manuals.

END OF DOCUMENT

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## 26 1200 MEDIUM VOLTAGE TRANSFORMERS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 "Identification for Electrical Systems".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) The primary voltage for projects at University Park Campus (UPC) shall be 4.8kV and for Health Sciences Campus (HSC) shall be 12.47kV.
    - b) Primary Device and Transformer: Connections shall be cable or copper flexible braid.
    - c) Transformer and Secondary Device: Connections shall be copper flexible braid.
  - 2. Preferred:
    - a) None
  - 3. Disallowed:
    - a) None.
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Pad-mounted, Liquid-filled Transformers:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) ASEA Brown Boveri
      - 2) Baltau Standard
      - 3) Square-D
      - 4) Cooper Industries
      - 5) General Electric
      - 6) Eaton/Cutler-Hammer

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- c) Disallowed: None
- 2. Component Characteristics (Required):
  - a) Provide Copper wound, 2-winding transformers.
  - b) Impedance rating shall be 5.75%  $\pm$ 6.5%.
  - c) Basic Impulse Level for UPC at Nominal Primary Voltage 5kV shall be 75kV and for HSC at Nominal Primary Voltage 15kV shall be 110kV.
  - d) Insulating Liquid shall be less-flammable oil, UL listed as complying with CEC requirements for fire point of not less than 300°C when tested according to ASTM D 92.
  - e) Both windings shall have epoxy insulation.
  - f) Cooling System: Class OA/FFA, self-cooled and with provisions for future forced-air cooled rating. Cooling systems shall include auxiliary cooling equipment, automatic controls and status indicating lights.
  - g) Full-Capacity Voltage Taps shall consist of (4) 2.5% taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and pad-lockable handle.
  - h) Insulation Temperature Rise shall be 55°C when operated at rated kVA output in a 40°C ambient temperature.
  - i) The insulation system shall allow an additional 12% kVA output at 65°C average winding temperature rise by resistance, on a continuous basis, without any decrease in normal transformer life.
  - j) Temperature Control: Transformer shall include fans and auxiliary equipment necessary for automatic temperature controlled forced air cooling to obtain an additional 15% capacity.
  - k) High-Voltage Terminations shall be dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:
    - 1) Bushing-Well Inserts: One for each high-voltage bushing well.
    - 2) Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
    - 3) Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.
  - l) Sound level may not exceed sound levels listed in NEMA TR1, without fans operating.
  - m) Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 0553 "Identification for Electrical Systems."
  - n) Preferred:
    - 1) Insulating liquid shall be biodegradable and nontoxic.
    - 2) Paint color shall be green or grey.
  - o) Disallowed:
    - 1) Aluminum wound transformers.
- B. Accessories:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: Same as A.1.b) listed above.
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:

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- 1) Combination Drain and Filer Valve: 1 inch, with sampling device
  - 2) Dial-type top liquid thermometer
  - 3) Magnetic liquid-level gage
  - 4) Pressure-vacuum gage
  - 5) Pressure Relief Device: Self-sealing with an indicator
  - 6) Mounting provisions for low-voltage current transformers
  - 7) Mounting provisions for low-voltage potential transformers
  - 8) Busway terminal connection at low-voltage compartment
  - 9) Cooling fans
  - 10) Auxiliary control equipment
  - 11) Alarm contacts for gages and thermometer listed above
- b) Preferred: None
- c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. Examine roughing-in of conduits and grounding systems to verify the following:
  - a) Wiring entries comply with layout requirements.
  - b) Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
2. Examine walls, floors, roofs and concrete bases for suitable mounting conditions where transformers will be installed.
3. Verify that ground connections are in place and that requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
4. Proceed with installation only after unsatisfactory conditions have been corrected.
5. Install transformers in accordance with manufacturer's written instructions and as shown on the drawings:
  - a) Anchor transformers to concrete bases according to manufacturer's written instructions and applicable seismic codes.
  - b) Provide concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.
  - c) Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 03 30 00 - Cast-in-Place Concrete.
  - d) Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
  - e) Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
  - f) Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions and directions furnished with items to be embedded.
  - g) Tack-weld or bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.
6. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and CEC.
7. Connections:

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- a) Primary Device and Transformer: Connections shall be cable or copper flexible braid.
  - b) Transformer and Secondary Device: Connections shall be copper flexible braid.
  - c) All connections shall be with copper wire.
  - d) Ground equipment according to [Section 26 05 26 “Grounding and Bonding for Electrical Systems.”
  - e) Connect wiring according to Section 26 05 19 “Low Voltage Electrical Power Conductors and Cables“ and Section 26 05 13 “Medium Voltage Cables”
- B. Preferred: None
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Transformers.
- B. Documentation required:
- 1. Field Quality Control: The contractor shall engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.
- C. Required testing protocols:
- 1. Perform the following field tests and inspections and prepare test reports:
    - a) After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
    - b) After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
    - c) Testing shall include IR scanning of all electrical connections once energized. Test report shall include digital and thermal photographs of all scans including equipment that is both abnormal and normal.
    - d) Perform visual and mechanical inspection and electrical test stated in NETA ATS 7.2. Certify compliance with test parameters.
    - e) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 2. Remove and replace malfunctioning units and retest as specified above.
  - 3. Test Reports: Prepare written reports to record the following:
    - a) Test procedures used.
    - b) Test results that comply with requirements.
    - c) Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.
  - 4. Follow up Service: Voltage Monitoring and Adjusting: If requested by the University’s Representative, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance
    - a) During a period of normal load cycles as evaluated by the University’s Representative, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration

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traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.

- b) Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate
  - 1) Adjust transformer taps.
  - 2) Prepare written request for voltage adjustment by electric utility.
- c) Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
- d) Report: Prepare written report covering monitoring and corrective actions performed.

**END OF DOCUMENT**

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## 26 1316 MEDIUM VOLTAGE FUSIBLE INTERRUPTER SWITCHGEAR

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 "Identification for Electrical Systems".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to Medium Voltage Fusible Interrupter Switchgear. The actual voltage ratings shall be as indicated on the drawings.
    - b) The entire assembly for the switchgear shall be rated to withstand mechanical forces exerted during short-circuits at available fault current.
    - c) Do not interrupt electric service to facilities occupied by University or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
      - 1) Notify University in writing no fewer than 21 days in advance of proposed interruption of electrical service.
      - 2) Do not proceed with interruption of electrical service without University's written permission.
    - d) Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:
      - 1) Ambient temperature not exceeding 122°F.
      - 2) Altitude of 250 feet above sea level.
    - e) The Work under this section is subject to the requirements of the Contract Documents including the General Conditions, Supplementary Conditions, sections under Division 01 General Requirements, following codes and standards:
      - 1) Comply with CEC
      - 2) Furnish products listed and classified by Underwriters Laboratories, Inc [or by a testing agency acceptable to Authorities Having Jurisdiction] as suitable for purpose specified and indicated.
      - 3) Comply with IEEE C2



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- 4) Comply with IEEE C37.20.3
  2. Preferred: None
  3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

#### A. SWITCHGEAR:

1. Manufacturers:
  - a) Required: Obtain each type of switchgear and associated components through one source from a single manufacturer.
  - b) Preferred:
    - 1) Square D
    - 2) Eaton
    - 3) General Electric
    - 4) S&C
  - c) Disallowed: None
2. Component Characteristics (Required):
3. RATINGS:
  - a) Maximum System Voltage: 15kV
  - b) Basic Impulse Level: 95kV
  - c) Main-Bus Rating: 600 A, continuous
  - d) Short Circuit Current Rating: 500MVA or larger as needed, rms asym
  - e) Short Time Current (Two Second): [as needed by project], rms sym
  - f) Momentary Current (10 Cycles): [as needed by project], rms asym
4. Enclosure:
  - a) Provide NEMA 3R with sloped drip-proof roof for outdoors and NEMA 1 for indoor units.
  - b) The enclosures shall be deadfront, completely metal enclosed enclosure consisting of free-standing self-supporting floor-mounted equipment bays.
  - c) Each equipment bay shall be a separately constructed cubicle
  - d) Integrated switchgear assembly shall safely withstand effects of closing, carrying and interrupting currents up to maximum short circuit rating.
  - e) Enclosure, covers, doors shall be minimum 11-gauge steel.
  - f) Provide a removable top cover rear door latch closed by tamper resistant pad lockable latches for each vertical section.
  - g) Provide a single full length, flanged front door equipped with 2 rotary latch type pad lockable handles for each vertical section.
  - h) Cubicles are to be designed for front and rear access.
  - i) Door shall be hinged on the opposite side of the switch operator to provide clear access for operation.
  - j) All openings shall be screened to prevent the entrance of small animals and barriered to inhibit the entrance of dirt, dust, etc.
5. Bus:
  - a) Phase buses shall be silver plated copper, rated 600 amperes.
  - b) Provide continuous silver plated copper ground bus through switchgear assembly. Connect bus to steel frame of vertical section
  - c) Ground bus shall be sized for rated (2-second) current of switchgear.
  - d) All bussing shall be braced for the maximum available fault current.

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- e) Main bus and ground bus shall be drilled to allow for future extensions
  - f) Cutout areas with removable covers for future extension of busses.
6. Load Interrupter Switch:
- a) Fixed mounted, manual three-pole gang operated with stored energy option.
  - b) Quick-make, quick-break over-toggle-type mechanism with speed of operation independent of operator.
  - c) Provided with separate main and break contacts
  - d) Provided with insulating barriers between phases and between phases and enclosure.
  - e) Provided with OPEN and CLOSED switch position indicators.
  - f) Provided with provisions for pad locking switch in open or close positions.
  - g) Provided with a high impact viewing window that permits full view of the position of all three switch blades through the closed door.
  - h) Provided with a fuse access door interlocked with the switch so that the switch must be opened before access to the fuse is possible and the door must be closed before the switch can be closed.
7. Switch Operators:
- a) Spring operator assembly shall be isolated from high voltage and coupled through direct drive shaft.
  - b) Switch operating handle shall be
    - 1) Permanently attached to front of switchgear
    - 2) Covered by full height solid door for outdoor applications
8. Fuses:
- a) Fuses shall be explosion type.
  - b) Fuse ampacity: as shown on drawings
  - c) Short Circuit Current Rating: as shown on drawings
  - d) Fuse Maximum Nominal Voltage Rating: 15kV
9. Surge Arresters:
- a) Provide 3 surge arrestors on line side of switchgear
  - b) Surge arrestors shall be rated per manufacturer's recommendation.
  - c) Provide a fully shielded, dead front, metal-oxide, elbow type surge arrester with resistance-graded gap suitable for plugging into inserts.
  - d) Connect the primary surge arrestors using manufacturers' jumper cables.
10. Wiring Terminations:
- a) Provide wiring, terminal blocks and fuse blocks within vertical section as required.
  - b) Control wiring shall be labeled with wire markers.
  - c) Wire termination system shall be provided such that no additional cable bracing, tying or lashing is required to maintain short circuit withstanding rating of assembly.
  - d) Each cubicle sections, which contain lugs for incoming and/or outgoing feeders, shall be equipped with horizontal cable supports.
11. Nameplates:
- a) Engraved, laminated-plastic or metal nameplate for each switch, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."
12. ACCESSORIES
- a) Communication Equipment
    - 1) Each switch shall communicate switch position (OPEN and CLOSED) via an addressable relay.

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- 2) Addressable relay shall: i) communicate a blown fuse condition. ii) Monitor an auxiliary switch contact that monitors the primary switch position. iii) Be rated for application. iv) Have a unique address to enable a host computer to call-p and read the switch position.
- b) Key Interlocks:
  - 1) Install key interlocks on duplex switches such that only one access door can be opened at a time and only if both switches are open.
  - 2) Provide warning sign which states: "Caution – Load side of switch and fuses may be energized unless both switches are open".
13. Preferred: None
14. Disallowed: None.

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. Install switchgear in accordance with manufacturer's written instructions, as shown on the drawings.
2. Switchgear shall be installed and anchored level on minimum 4" high concrete base to withstand seismic forces as required per code.
3. Verify that required utilities are available, in proper location and ready for use.
4. Coordinate fine locations of equipment with Contractor and review final locations with Architect/Engineer prior to setting equipment.
5. Protect equipment during installation to prevent twisting or deformations, exposure to potentially damaging environments and work of other trades. Maintain protection until completion of construction.
6. Verify tightness of accessible bolted bus joints with torque wrench prior to energizing switchgear. Tightness shall be in accordance with manufacturer's recommended values.
7. Conductor Bending
  - a) Bending of high-voltage cables should be avoided or minimized.
  - b) All necessary bends should meet the minimum radii specified by the cable manufacturer.
8. Identify field-installed wiring and components and provide warning signs as specified in Section 26 05 53 - Identification for Electrical Systems.

#### B. Preferred:

1. None.

#### C. Disallowed:

1. None.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Switchgear.
- B. Documentation required:
  1. Test reports: The contractor will engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations, bussing and protective devices.

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- C. Required testing protocols:
  - 1. Protective device Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1 and 7.5 as appropriate. Certify compliance with test parameters.
  
- D. Manufacturer's Field Service:
  - 1. Engage a factory-authorized service representative to inspect and adjust field assembled components and equipment installation, including connections.
  - 2. Prior to energization, factory representative shall visually inspect the switchgear installation to insure that all switches and motor operators are operable and bus connections are complete.
  - 3. Switch operators shall be tested at least once after energization.
  - 4. Contractor shall provide 3 copies of the manufacturer's representative's certification.
  
- E. Demonstration and Training:
  - 1. Engage a factory-authorized service representative to train University's maintenance personnel to adjust, operate and maintain switchgear.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 2213 LOW VOLTAGE DISTRIBUTION TRANSFORMERS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 "Identification for Electrical Systems".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to Dry Type Ventilated Transformers rated 600V and less, with capacities up to 300kVA.
    - b) All transformers shall be ventilated type with a maximum of 115°C rise above 40°C ambient temperature.
    - c) All transformers for use in applications with up to 50% non-linear loads shall be regular type.
    - d) All transformers for use in applications with more than 50% non-linear loads shall be K-4 rated.
    - e) All transformers for use in specialty applications shall be K-13 rated.
    - f) All transformers serving sensitive loads (i.e. A/V equipment) shall be equipped with Electrostatic Shielding.
  - 2. Preferred: None
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Transformers:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Square D
      - 2) Eaton
      - 3) General Electric

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- c) Disallowed: None
- 2. Component Characteristics:
  - a) Required:
    - 1) The coils' windings shall be copper of the fine-resistant type, air insulated and designed for natural convection cooling through normal air circulation.
    - 2) The coils shall be continuous windings without splices except for taps.
    - 3) The cores shall be of grain-oriented, non-aging silicon steel.
    - 4) The cores' mounting frames and enclosures shall be of the welded and bolted construction with sufficient mechanical strength and rigidity to withstand shipping erection and short circuit stresses.
    - 5) Transformers shall be equipped with four 2-1/2% (2 above and 2 below normal voltage) primary taps.
    - 6) All K-rated transformers shall be equipped with 200% neutral with double size neutral terminal.
    - 7) All transformers shall have a basic impulse insulation level of 10 KV.
    - 8) The sound levels shall meet NEMA ST-20 standards.
    - 9) Transformers shall be low loss type with minimum efficiencies per NEMA TP-1 when operated at 35% of full load capacity. Efficiency shall be tested in accordance with NEMA TP-2.
  - b) Preferred:
    - 1) Finish shall be ANSI 61 gray.
  - c) Disallowed:
    - 1) Transformers with Aluminum coil windings.

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Install transformers in accordance with manufacturer's written instructions as required.
  - 2. Transformers shall be anchored to withstand seismic forces as required per code.
  - 3. Provide a minimum 4" high concrete housekeeping pad. Coordinate actual dimensions with shop drawings and extend pad 3" in all directions beyond overall dimension of base. Provide reinforcing bars as required structurally within pad to insure proper support of equipment.
  - 4. Transformers shall be installed to provide adequate air circulation for the removal of the heat they produce, in accordance with manufacturer recommendations.
  - 5. Transformers not specifically designed for wall mounting, shall be spaced a minimum of 6" from adjacent walls and equipment.
  - 6. All wall-mounted transformers shall be installed level and plumb with wall brackets fabricated by transformer manufacturer.
  - 7. Install the transformers on the noise and vibration isolation mounts designed to suppress the transformer noise from the building structure. Select and arrange the mounts in accordance with the weight and mounting of the transformers. These mounts are in addition to any internal vibration pads. Vibration isolating mounts shall be seismically rated for the application.
  - 8. All conduits shall be isolated from the transformer enclosures by the use of neoprene grommets at conduit entrances to enclosure and the use of a

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grounding bushing. Flexible jumpers shall be installed for grounding continuity from enclosure to conduits or bus ducts.

9. Provide high-pressure compression lugs, for primary and secondary phase and neutral terminations for transformers 45 KVA and larger.
10. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum (+10% or -3% of nameplate voltage at maximum load conditions) voltage conditions at secondary terminals.

- B. Preferred: None
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Transformers.
- B. Documentation required:
  1. Test reports: The contractor shall engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations, primary and secondary protective devices.
- C. Required testing protocols:
  1. Transformer assemblies:
    - a) Inspect for physical and mechanical condition.
    - b) Check tightness of all terminations/connections.
    - c) Test for proper grounding
  2. Electrical Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.2.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 2413 SWITCHBOARDS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 "Identification For Electrical Systems", Section 26 05 73 "Overcurrent Protective Device Coordination Study" and 26 05 19 "Low Voltage Electrical Power Conductors and Cables".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to dead-front, low-voltage (600 V or less) distribution switchboards. The actual voltage ratings shall be as indicated on the drawings.
    - b) The entire assembly for all switchboards shall be rated to withstand mechanical forces exerted during short-circuits at available fault current.
    - c) All switchboard sections shall be a minimum of 24" deep and all individual sections shall line up evenly, front and rear.
    - d) All switchboards shall be equipped with a main breaker unless they are located in the same room as their upstream distribution breaker.
    - e) All main breaker shall be rated at 100% of switchboard capacity.
    - f) The primary breakers for Low-voltage distribution transformers shall be sized at 125% of the transformer-rated current.
    - g) The frame size for breakers with trip rating 110 amps and larger shall be minimum 10% larger than the trip rating.
    - h) All switchboards shall be furnished with minimum of 25% additional space, for future applications.
    - i) All switchboards shall be furnished with minimum of 20% spare capacity, for future applications.
    - j) All switchboards shall be furnished with minimum of 20% spare circuit breakers.
    - k) The loading for all switchboards shall be balanced and the difference between phase loads shall not exceed 15%.
  - 2. Preferred:
    - a) None
  - 3. Disallowed:



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- a) Switchboards with series-connected rating with integral or remote upstream overcurrent protective devices.
- b) Tapered bus is not permitted. The neutral bus shall be of equivalent ampacity as the phase bus bars for 4-wire systems.

B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

A. Switchboards:

- 1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Square D
    - 2) Eaton
    - 3) General Electric
  - c) Disallowed: Others
- 2. Component Characteristics:
  - a) Required:
    - 1) All switchboards shall be of unit construction with all parts designed, manufactured and assembled by a single manufacturer.
    - 2) All switchboards shall be floor mounted, self-supporting, front connected, front accessible switchboards, manufactured complete with all parts, fittings and components.
    - 3) All switchboards shall consist of the required number of vertical sections bolted together to form a rigid assembly with barriers between adjacent sections.
    - 4) All switchboards shall be bused for the full height of all distribution sections. Bussing in all sections shall be sized to carry anticipated connected loading.
    - 5) All switchboards shall be equipped with mounting brackets, supports, bus connections and appurtenances at full rating of circuit-breaker compartment. Bussing for all "spaces" shall be drilled and ready for the installation of future circuit breakers.
    - 6) Provide switchboards with silver-plated Copper bussing.
    - 7) All bus bars shall be hard-drawn copper of 98% conductivity copper with feeder circuit-breaker line connections.
    - 8) All switchboards shall be furnished with a copper ground bus that is secured to each vertical section structure and is extended the entire length of the switchboard.
    - 9) Provide mechanical-type lugs for all line and load terminations that are suitable for number, size, trip rating and conductor material.
    - 10) All overcurrent protective devices shall be insulated-case, molded-case thermal-magnetic or static trip electronic type circuit breakers as required.
    - 11) The AIC rating of all circuit breakers and busses shall be sized based on fault current analysis.
    - 12) All breakers shall be equipped with adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

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- 13) All 600A and larger frame breakers shall have electronic trip-units that have RMS sensing, field-replaceable rating plug and the field-adjustable (Instantaneous trip, L & S time pickup, L & S time adjustments, GF pickup level, time delay and I<sup>2</sup>t response) settings.
  - 14) The main circuit breaker for the building (service entrance) shall be individually mounted and 100% rated.
  - 15) Provide Ground Fault protection function only at service main circuit breaker(s) and/or for all circuit breakers over 1000A connected to 277/480V, 3-phase, 4-wire systems as required by Code.
  - 16) All control power requirements shall be fed from an integral transformer within each switchboard.
  - 17) Customer monitoring and metering equipment shall be as stated in 26 0000 "Electrical Design Requirements - Electrical Metering" section.
    - b) Preferred:
      - 1) Finish shall be ANSI 61 gray.
      - 2) Main circuit breaker is preferred to be a drawout type breaker if project also includes an ATS with maintenance bypass isolation.
    - c) Disallowed:
      - 1) Switchboards with Aluminum bussing.
      - 2) Switchboards with fused switches.
- B. Generator Quick Connect Switchboard:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Eaton TD01500001K
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Generator quick connect switchboard shall be a free-standing, dead-front type low voltage switchboard utilizing a main circuit protective device, generator lug and receptacle connections as shown on the contract drawings.
      - 2) Assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current 65,000 amperes symmetrical as shown on drawings.
      - 3) Generator quick connect switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly.
      - 4) The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed.
      - 5) The switchboard shall be provided with load connection options to cross bus or mechanical outgoing cable terminations, which shall be suitable for copper conductors.
      - 6) Provide switchboards with silver-plated Copper bussing.
      - 7) All switchboards shall be furnished with a copper ground bus that is secured to each vertical section structure and is extended the entire length of the switchboard.

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- 8) Provide both mechanical-type lugs and cam-type receptacle assembly for connection of generator power phases (A,B,C), neutral and ground conductors.
- 9) Cam-type receptacles must be suitable for use in outdoor environments.
- 10) Refer to Exhibit for connection one line.
- b) Preferred: Finish shall be ANSI 61 gray.
- c) Disallowed:
  - 1) Switchboards with Aluminum bussing.

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  1. Install switchboards in accordance with manufacturer's written instructions, as shown on the drawings.
  2. Freestanding switchboards shall be accurately aligned, leveled and bolted in place on full-length channels securely fastened to concrete floor.
  3. The centerline of highest mounted breaker handle shall not exceed 6'-6" above finished floor.
  4. Switchboards shall be installed and anchored level on minimum 4" high concrete base to withstand seismic forces as required per code.
  5. Check and tighten all bolts and connections with a torque wrench using manufacturer's recommended values.
  6. "Train" interior wiring; bundle and clamp, using specified plastic wire wraps specified under Section 26 0519 "Low Voltage Electrical Power Conductors & Cables".
  7. Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.
- B. Preferred:
  1. None.
- C. Disallowed:
  1. None.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Switchboards.
- B. Documentation required:
  1. Test reports: The contractor will engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations, bussing and protective devices.
- C. Required testing protocols:
  1. Switchboard assemblies:
    - a) Inspect for physical and mechanical condition.
    - b) Check tightness of all terminations/connections.

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- c) Test insulation resistance for each switchboard bus, component, connecting supply, feeder and control circuit.
  - d) Test continuity of each circuit.
  - e) Test resistance to ground of system and equipment ground connection.
2. Protective device Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.6, 7.9, 7.10, 7.11 and 7.14 as appropriate. Certify compliance with test parameters.

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**6. Exhibits**



# Cutler-Hammer

## Generator Quick Connect Switchboard

Technical Data TD01500001K



**Generator Quick Connect Switchboard (Typical of 1600 A)  
With Type 3R Enclosure**

### Product Description

The Eaton Generator Quick Connect Switchboard is an engineered assembly designed to allow safe and fast connection of a mobile generator to your facility's electrical system or a portable load bank.

Through inclusion of cam-type receptacles, standard mechanical lugs, dedicated generator-service disconnect, and a manual key-interlock transfer scheme, you can quickly and safely supply emergency power parts of your electrical power system that are not currently covered by your emergency power system, or you can back-up existing generators.

Loads connected to the Generator Quick Connect Switchboard, available in both Type 1 and Type 3R enclosures, can immediately be safely transitioned to an alternative power source, made possible by the Generator Quick Connect Switchboard.

### Benefits of the Generator Quick Connect Switchboard

#### Speed of Connection

With a Generator Quick Connect Switchboard installed, the owner does not have to do any of the following that are common in emergency power situations:

- No making additional field modifications to an internal switchboard in order to connect the generator cables after the initial installation.
- No modifying the building's physical structure to accommodate generator cables (e.g., drilling holes in walls).
- No running cables through doorways or windows and through hallways or up stairs.

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**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 2416 PANELBOARDS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 0553 "Identification For Electrical Systems", Section 26 05 73 "Overcurrent Protective Device Coordination Study", 26 24 13 "Medium Voltage Cables" and 26 05 19 "Low Voltage Electrical Power Conductors and Cables".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to distribution, lighting and appliance branch-circuit panelboards.
    - b) All panelboards shall be fully rated to interrupt symmetrical short-circuit current available at terminals
    - c) All panelboards that are not located in the same room as their distribution breaker shall have a main breaker provided in the panel. Exceptions may be made for panels located on the same floor as their distribution breaker, determined on a case by case basis on approved by FPM Engineering.
    - d) All panelboards shall be furnished with minimum of 25% spare circuit breakers.
    - e) All panelboards shall be furnished with a minimum of 20% spare capacity.
    - f) Provide minimum 42-circuit and up to 84-circuit panelboards for 120/208V and 277/480V systems.
    - g) Provide isolated ground bus for all 120/208V panelboards serving non-linear loads.
    - h) Provide neutral bus that is rated 200% of phase bus for panelboards serving non-linear loads and served by K-rated transformer.
    - i) The loading for all panelboards shall be balanced and the difference between phase loads shall not exceed 15%.
  - 2. Preferred:
    - a) None
  - 3. Disallowed:
    - a) Multiple section panelboards installed in adjoining cabinets and fed from a single feeder are not allowed.



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- b) Panelboards with series-connected rating with integral or remote upstream overcurrent protective devices.
- c) Feed through panels are not acceptable for new construction. For existing conditions that have feed through panels, load may be added but additional feed through panels should not be included.

B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

A. Panel Boards:

- 1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Square D
    - 2) Eaton
    - 3) General Electric
  - c) Disallowed: All others
- 2. Component Characteristics:
  - a) Required:
    - 1) Provide panelboards with Copper bussing.
    - 2) Provide panelboards with bolt-on type, thermal magnetic circuit breakers.
    - 3) The AIC rating of all circuit breakers and busses shall be sized based on fault current analysis.
    - 4) The main circuit breaker shall be installed vertically on the top or the bottom of panel. Installing the main breaker at branch circuit location is not acceptable
    - 5) Circuit breakers feeding "Fire Alarm Control Panel(s)" shall be red in color and shall have handle locks.
    - 6) Provide 3-phase, 4-wire panelboards with 208/120V or 480/277V system panelboards, as indicated on the Drawings.
    - 7) Panelboard cabinets shall be of code gauge galvanized steel with minimum dimensions of 20" wide by 5-3/4" deep, height as required, unless noted otherwise on the Drawings.
    - 8) Provide panelboards with hinged lockable door that is equipped with concealed hinge, latch and flush locks that are keyed to operate from a single key.
    - 9) Provide panelboards with index/directory card that is fitted in a transparent protective cover, mounted in metal frame, inside panelboard door.
    - 10) Provide distribution panelboards with bolt-on devices contained therein with interrupting ratings as indicated on the drawings. Distribution panelboards shall have molded-case or electronic static trip breakers as required.
  - b) Preferred:
    - 1) Panelboards are preferred to have progressive or continuous hinges with door in door construction.
    - 2) Finish shall be ANSI 61 gray.
  - c) Disallowed:

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- 1) Panelboards with Aluminum bussing.
- 2) Load Centers.

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. Install panelboards in accordance with manufacturer's written instructions, as shown on the drawings.
2. Set panels plumb and symmetrical with building lines in conformance with NEMA PB1.1. Furnish and install all construction channel bolts, angles, etc., required to mount the equipment furnished under this Section.
3. Mounting height shall be 6'-0" to top of panelboard or 6'-6" to the centerline of highest mounted breaker handle.
4. Panelboards shall be anchored and braced to withstand seismic forces as required per code.
5. Panelboards located in mechanical areas shall have weatherproof gaskets on trims and doors.
6. Panelboards installed in damp locations, on exterior walls of basements or areas exposed to moisture shall be mounted with a minimum 1" of gap between back of the cabinet and the wall or other supports.
7. Panelboard cabinets shall be rigidly supported in place independent of the conduits with minimum two rows of steel channels.
8. Check and tighten all bolts and connections with a torque wrench using manufacturer's recommended values.
9. "Train" interior wiring; bundle and clamp, using specified plastic wire wraps specified under Section 26 05 19 "Low Voltage Electrical Power Conductors & Cables".
10. Provide a neatly typewritten schedule with the number or name of the room or area or the equipment/device served by each panel board circuit.

#### B. Preferred:

1. Panelboards are not permitted to be located outside electrical rooms or closets without prior approval by the University's Representative.
2. Panelboards installed outside the electrical and utility rooms that are exposed to public view shall be flush mounted.
3. Provide (2) 1" and (2) 3/4" spare conduits stubbed-out of flush mounted panelboards to the nearest accessible ceiling space or other accessible location and cap for future use.

#### C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

#### A. List of items or systems requiring testing, evaluation, verification, or commissioning: Panelboards.

#### B. Documentation required:

1. Test reports: The contractor will engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations, bussing and protective devices.

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- C. Required testing protocols:
1. Panelboard assemblies:
    - a) Inspect for physical and mechanical condition.
    - b) Check tightness of all terminations/connections.
    - c) Test insulation resistance for each panelboard bus, component, connecting supply, feeder and control circuit.
    - d) Test continuity of each circuit.
    - e) Test each panel for proper grounding
  2. Protective device Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 2419 MOTOR CONTROL

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 "Identification for Electrical Systems".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to manual or magnetic motor starters that are individually mounted or group mounted in a multi-section, floor mounted Motor Control Center (MCC) assembly.
    - b) The entire assembly for all MCCs shall be rated to withstand mechanical forces exerted during short-circuits at available fault current.
    - c) All MCC sections shall be a minimum of 20" deep and all individual sections shall line up evenly, front and rear.
    - d) All MCCs shall be equipped with a main breaker unless they are located in the same room as their upstream distribution breaker.
    - e) All MCCs shall be furnished with minimum of 25% additional space, for future applications.
    - f) All MCCs shall be furnished with minimum of 20% spare capacity, for future applications.
    - g) All MCCs shall be furnished with minimum of 20% spare combination breaker/starter units.
  - 2. Preferred:
    - a) None
  - 3. Disallowed:
    - a) MCCs with series-connected rating with integral or remote upstream overcurrent protective devices.

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- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

#### A. MOTOR CONTROL CENTERS (MCC)

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Square D
    - 2) Eaton
    - 3) General Electric
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) All MCCs shall be of unit construction with all parts designed, manufactured, assembled and tested by a single manufacturer to assure complete and proper coordination between all items.
    - 2) All MCCs shall consist of one or more vertical sections of heavy gauge steel bolted together to form a rigid, freestanding assembly.
    - 3) All sections and busing shall be designed for readily adding or removing a section. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.
    - 4) All sections shall contain horizontal wireways, isolated from the buses and shall be readily accessible through a hinged cover. Align each section with adjacent sections to form unobstructed wiring raceways along entire length of MCC. Vertical wireways shall be equipped with cable tie supports to hold cables and wiring in place in each section. Vertical space shall be clear of obstruction for laying out wiring and readily accessible by a full height hinged cover.
    - 5) All sections shall have all the necessary hardware and bussing for modular draw-out units to be added and moved around. All unused space shall be covered by hinged blank doors and equipped to accept future units. Vertical bus openings shall be covered by bus shutters.
    - 6) All starter units shall be of the plug-on type. Starter units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend into the bus compartment. Units shall be equipped with side-mounted, positive latch pull-apart type control terminal blocks rated 600-volts. Knockouts shall be provided for the addition of future terminal blocks. Each unit compartment shall be provided with an individual front door.
    - 7) Compartments for mounting control units shall be incrementally arranged such that not more than six (6) size "1" starters for front mounted only units can be mounted within each vertical structure.
    - 8) An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access unless disconnect is in the OFF position. Padlocking facilities shall be provided to positively lock disconnect in the OFF position with from one (1) to three (3) padlocks with the door open or closed. In addition, means shall be provided to padlock the

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unit in a partially withdrawn position with the stabs free of the vertical bus.

- 9) Each section shall contain a main horizontal copper silver-plated bus, with minimum ampacity of 600 amperes unless otherwise noted. The horizontal bus shall be rated at 50°C temperature rise over a 40°C ambient in compliance with UL standards. Vertical busses feeding unit compartments shall be copper and shall be securely bolted to the horizontal main bus. All joints shall be front accessible for ease of maintenance. Each section shall be bussed for the full height of the section. The vertical bus shall have a minimum rating of 300 amperes or as required by the connected loads.
- 10) A tin-plated copper ground bus with a cross-section equal to at least 25% of the capacity of the main bus rating shall be provided that runs the entire length of MCC, bolted to all sections and include terminal lugs.
- 11) Isolation of the vertical bus compartment from the unit compartment shall be by means of a full height insulating barrier. This barrier shall be a single sheet of glass reinforced polyester with cutouts to allow the unit stabs to engage the vertical bus. Provide snap-in covers for all unused openings.
- 12) All bus supports shall be of high dielectric strength, low moisture absorption, molded compound with high impact strength and low leakage surface.
- 13) The AIC rating of all circuit breakers and busses shall be sized based on fault current analysis.
- 14) Wiring/Terminations: Wiring shall be NEMA Class II Type B. All control wiring shall be minimum #14 AWG.
- 15) All Starter units shall be combination type (starters with instantaneous magnetic trip circuit breaker) with all features and components as specified in the previous articles.
- 16) Each starter shall be equipped with its own control transformer, unless otherwise noted. Transformers shall be sized and protected per manufacturer's printed recommendations. The transformer shall be sized to accommodate the contactors and all connected control circuit loads.
- 17) When a unit control transformer is not furnished with the starter, Provide a separate source disconnect switch for each circuit brought into a starter or relay enclosure from a voltage source external to the starter.
- 18) Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to N.O. or N.C. operation. Refer to Division 23 and related Sections, including approved control shop drawings.
- 19) Enclosure shall be NEMA 3R for outdoors and NEMA 1A (gasketed) for indoors.
  - b) Preferred: Finish shall be ANSI 61 gray.
  - c) Disallowed: MCCs with Aluminum bussing.

### B. MANUAL MOTOR STARTERS

1. Manufacturers:
  - a) Required: No requirements

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- b) Preferred:
  - 1) Square D
  - 2) Eaton
  - 3) General Electric
- c) Disallowed: None
- 2. Component Characteristics:
  - a) Required:
    - 1) Fractional Horsepower Manual Starters: AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit and toggle operator.
    - 2) Manual Motor Starters: AC general purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with integral overload relay and pushbutton operator.
    - 3) Manual Motor Starters: Provide red pilot light and auxiliary contacts, 1 N.O. and 1 N.C.
    - 4) Manual Motor Starters: Provide provisions for padlocking in the OFF position.
    - 5) Manual Motor Starters: The starter shall have accessories such as auxiliary contacts, trip alarm and shunt trip available for field installation.
    - 6) Starter size and number of poles shall be as required for connections shown on drawings. Furnish in conformance with NEMA ICS 2.
    - 7) Enclosure: NEMA ICS 6; Type 1 for indoor and Type 3R for outdoor applications, unless otherwise noted.
  - b) Preferred: None
  - c) Disallowed: None.

### C. ELECTRO-MECHANICAL MOTOR STARTERS

- 1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Square D
    - 2) Eaton
    - 3) General Electric
  - c) Disallowed: None
- 2. Component Characteristics:
  - a) Required:
    - 1) Provide magnetic starters for motors rated in horsepower, conforming to NEMA ICS 2. Starters shall be equipped with double-break silver alloy contacts and molded construction coils.
    - 2) Furnish with electronic overload relay protection in all three phases. Overload relays shall be reset from outside the enclosure by means of an insulated button.
    - 3) All starters shall be such that disconnection of power conductors shall automatically disconnect control power.
    - 4) Each starter unit shall have two N.O. and two N.C. auxiliary contacts.
    - 5) Each starter unit shall have heavy-duty oil tight H-O-A switch.
    - 6) Each 480V AC starter shall contain a separately fused, heavy-duty control transformer within each motor starter compartment to provide 120V AC, 60 Hz. Control transformer shall be adequate VA rating for

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all control/indicator components. Factory pre-wired fuse and fuse holder in the ungrounded leg of the control transformer primary and secondary.

- 7) Three phase solid-state power monitor for anti-single phasing protection on motors 20 HP and larger. Cutler Hammer SVM3 series, General Electric or equal.
  - 8) All starters shall be full-voltage, non-reversing, (FVNR), minimum NEMA size 1, unless otherwise noted.
  - 9) The operating handle shall have a means to lock the handle in the OFF position.
  - 10) Starters other than FVNR shall be equal in quality and by same manufacturer of starters specified above. Other types of starters, if required, shall be as described on the Drawings.
- b) Preferred: None
  - c) Disallowed: None

### D. COMBINATION STARTERS WITH OVERCURRENT PROTECTION DEVICE

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Square D
    - 2) Eaton
    - 3) General Electric
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Combination motor starters shall conform to all of the requirements for magnetic starters, plus have a motor circuit protective device in the same enclosure conforming to the California Electrical Code (CEC) requirements for the motor operation. The protective device shall be interlocked with the cover door to prevent opening of the door unless disconnect is in open position.
    - 2) Motor Circuit Protectors: Adjustable instantaneous trip, magnetic only circuit breakers shall be provided for all combination motor starters. A manual push to trip button shall be provided to test the trip unit.
    - 3) Motor Circuit Protectors: Circuit breakers shall be molded case, Square D "Mag-Gard" series, Eaton "HMCP" series or equal by GE.
    - 4) Motor Circuit Protectors: The actual trip rating shall be adjusted per HP rating and as recommended
    - 5) Motor Circuit Protectors: Combination starters with adjustable instantaneous trip, magnetic only circuit breakers shall be sized based on fault current analysis.
    - 6) Fusible Disconnect Switches: Fusible disconnect switches with double break, rotary blades and quick-make/quick-break action type utilizing class R fuse clips shall be provided.
    - 7) Fusible Disconnect Switches: A removable line shield with test probe holes for inspection shall be provided.
    - 8) Fusible Disconnect Switches: The switch shall have readily visible blades in the open (OFF) position.



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- 9) Fusible Disconnect Switches: The fusible disconnect switch (through 100A) shall have built-in fuse pullers to make it easier to remove fuses.
- 10) Fusible Disconnect Switches: Fusible disconnect switches shall be UL listed for 100,000 amperes fault with class R fuses.
  - b) Preferred: None
  - c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

- 1. Install motor control equipment in accordance with manufacturer's instructions and as specified herein.
- 2. Provide a 4" high concrete housekeeping pad beneath equipment. Coordinate actual sizes of equipment base with shop drawings and extend pad in all directions beyond overall dimension of base as required. MCC shall be anchored and braced to withstand seismic forces as required.
- 3. Provide construction channel and mounting hardware as required to support motor control equipment. Provide reinforcing bars as required structurally within pad to insure proper support of equipment.
- 4. Coordinate locations of MCC and control equipment in the field to provide code clearances in front of equipment or devices. The mounting height of highest operable device (centerline of handle) shall not exceed 6'-6" above finish floor regardless of the pad height.
- 5. Termination of conduits entering the top of MCCs shall constitute a tight and continuous metal-to-metal contact by penetrating the finish paint on enclosure. Conduits entering the bottom shall be provided with grounding bushings with neoprene throat inserts. Each busing shall be connected to the MCC ground bus with #4 AWG insulated ground conductor.
- 6. Incoming cables shall enter control center from bottom or top as required by individual installation. Include a 12" cable section with physical and electrical clearance for convenience in connecting cables to buses. Provide cable ties for cables from point of entrance to respective device terminals.
- 7. Provide engraved, machine screw-retained type 'NP' nameplate on each motor control device.
- 8. Upon completion of project prior to final acceptance the contractor shall thoroughly clean both the interior and exterior of MCC and motor controls per manufacturers approved methods and materials. Remove paint splatters and other spots, dirt and debris.
- 9. Touch-up paint any marks, blemishes, or other finish damage suffered during installation.
- 10. Identification and labeling: Provide labeling for identification as required per specification section 26 05 53 "Identification for Electrical Systems":
  - a) All motors shall be labeled per naming designations indicated on contract documents.
  - b) All motors shall also be labeled to identify space and/or equipment they are serving.

#### B. Preferred:

- 1. None

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- C. Disallowed:
  - 1. None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Motor Control Centers (MCCs) and any individually mounted motor controllers.
- B. Documentation required:
  - 1. Test reports: The contractor shall engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations, bussing and protective devices.
- C. Required testing protocols:
  - 1. MCC assemblies:
    - a) Inspect for physical and mechanical condition.
    - b) Check tightness of all terminations/connections.
    - c) Test insulation resistance for each MCC bus, component, connecting supply, feeder and control circuit.
    - d) Test continuity of each circuit.
    - e) Test resistance to ground of system and equipment ground connection.
  - 2. Protective device Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.16 as appropriate. Certify compliance with test parameters.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 2713 ELECTRICITY METERING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to electricity metering.
  - 2. Preferred: None
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Microprocessor-Based Metering Equipment:
  - 1. Manufacturers:
    - a) Required:
      - 1) Eaton
    - b) Preferred: N/A
    - c) Disallowed: All others.
  - 2. Component Characteristics (Required):
    - a) Main Distribution Board: PXM6000
    - b) Distribution Mains: IQ-150 w/LED Display (IQ150MA6511)
    - c) Branch Distribution: IQ-150 w/LED Display (IQ150MA6511)
    - d) ATS: IQ-150 w/LED Display (IQ150MA6511)
    - e) Current Transformer Shorting Block for all meters
    - f) Gateway: PXG200E
  - 3. Gateway Power Supply
    - a) Eaton PSG60E
      - 1) Input voltage range 85-264 VAC, 1 phase
      - 2) Output voltage, 24 VDC
      - 3) Output current, max 2.5A

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### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. All cabling is required to meet Eaton Cabling Spec TD17513
    - a) Cabling for Modbus network
      - 1) Single twisted pair
      - 2) Double twisted pair for multiple devices in the network
      - 3) 120 ohm impedance rating
      - 4) 12pF max. capacitance per foot
      - 5) Min 24AWG
        - 300V installations – Belden 9841
        - 600V installations – Belden 3074F
  - 2. If more than one device is installed,
    - a) All devices shall be wired in a daisy chain fashion as defined in Eaton Cabling Spec TD17513 Figure 1
    - b) A loop back shall be provided.
- B. Preferred: None
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. The Eaton Power Monitoring System (EPMS) installer shall be an Eaton Certified PowerXpert Engineer with an official certificate of training from Eaton University.
- B. Certified PowerXpert Engineer shall certify that the equipment has been installed, adjusted, and tested in conformance with the manufacturer's recommendations.
- C. All EPMS equipment, engineering, and commissioning services shall be from one manufacturer, with equipment being UL approved.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 2713.1 ELECTRICAL CONSTRUCTION POWER MONITORING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to electrical power monitoring specifically related to temporary power for use during construction activities.
  - 2. Preferred: None
  - 3. Disallowed: None
- B. All equipment, engineering, and commissioning services shall be from one manufacturer with equipment being UL approved.

### 3. PRODUCT REQUIREMENTS

- A. Electrical Metering Components:
  - 1. Electrical Meter:
    - a) Dent Instruments Elitepro XC portable recording power meter
  - 2. Current Transformers:
    - a) Dent Instruments RoCoil Flexible CTs
      - 1) Provide 3 each of split core AC current transformer. Size shall be determined by service size.

### 4. INSTALLATION REQUIREMENTS

- A. INSTALLATION
  - 1. All cabling is required to meet manufacturer requirements.

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### **B. FIELD QUALITY CONTROL**

1. Project to coordinate with FPM Energy Services once meter is installed. FPM Energy Services will read and record data.

### **C. Test and Inspections:**

1. Connect a load to known kilowatt rating, 1.5kW minimum, to a circuit supplied by metered feeder.
2. Turn off circuits supplied by metered feeder and secure them in off condition.
3. Run test load continuously for one hour minimum, or longer to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
4. Prepare test and inspection reports.

## **5. EVALUATION or COMMISSIONING**

- A. Project to coordinate with FPM Energy Services once meter is installed. FPM Energy Services will read and record data.

**END OF DOCUMENT**

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## 26 2719 MULTI-OUTLET ASSEMBLIES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to multi outlet assemblies specifically related to outdoor Event Power.
  - 2. Preferred: None
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Lockable Weatherproof Enclosure:
  - 1. Manufacturers:
    - a) Required: None
    - b) Preferred:
      - 1) Appleton
      - 2) Crouse-Hinds
      - 3) Steel City
      - 4) T & B
      - 5) Raco
    - c) Disallowed: None
  - 2. Component Characteristics (Required):
    - a) NEMA 3R rated with hinged lockable cover.
    - b) Box to be 12" x 12" x 6" deep
    - c) Disallowed: Removable cover
  - 3. Requirements:
    - a) Locking mechanism will be an exterior mounted hasp/clasp type device lockable with use of a standard padlock.

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- B. Receptacles:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Hubbell
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Provide (2) 20A, 120V duplex 5-20R receptacles with weatherproof flip cover
      - 2) Provide (1) 50A, 208V, 1 $\Phi$ , C56369 receptacle with weatherproof flip cover

### 4. INSTALLATION REQUIREMENTS

- A. Required:
1. (2) 20A, 120V duplex receptacles shall be fed from (2) dedicated single pole 20A breakers, one for each duplex.
  2. 50A, 208V receptacle shall be fed from (1) dedicated 50A, 2 pole breaker.
  3. Lockable enclosure shall be labeled with engraved plate with "Event Power Box", "Fed From" panel and circuit including all circuits.
  4. Corresponding breakers in panel to be labeled with Outdoor Event Power.
  5. All unused mounting holes or other openings in the Lockable Enclosure shall be sealed to prevent water or moisture ingress.
  6. Lockable Enclosures not mounted on a wall or other solid stable surface (such as boxes mounted in planters or landscaping) shall be mounted on at least (1) 1 5/8" deep galvanized unistrut/metal channel.
    - a) Metal channel will be solidly attached to the entire horizontal or vertical dimension of the box.
    - b) Metal channel supporting the box will be solidly anchored into the ground by concrete base or by driving sufficient length of metal channel into the ground to prevent movement of the support.
  7. In planter or landscaping, boxes shall be mounted as low as reasonably possible to minimize visual impact, minimum of 6" above finished grade or landscaping.
  8. Preferred: None
  9. Disallowed: None



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### 5. REFERENCE EXHIBIT PHOTOS



Lockable Enclosure with Outlets



Enclosure on Unistrut



External Mounted Hasp/Clasp Type



Enclosure on Unistrut in Planter



Labeling for Event Power Box

**END OF DOCUMENT**

# FACILITY DESIGN GUIDELINES

## 26 2726 WIRING DEVICES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 "Identification for Electrical Systems".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to wiring devices.
    - b) All devices shall conform to National Electrical Manufacturer's Association (NEMA) standards and shall be Underwriters Laboratories, Inc., (UL) listed and labeled.
    - c) All devices, where applicable, shall be "Specification Grade" Industrial/heavy-duty type, meeting the requirements of Federal Specification WC-596-F for receptacle and meeting the requirements of Federal Specification WS-896-E, for switches.
    - d) All devices shall be of the same manufacturer, where applicable.
    - e) All dimmer circuits shall have a dedicated neutral conductor, refer to Section 26 05 53 "Identification for Electrical Systems" for conductor color coding requirements.
  - 2. Preferred: None
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. RECEPTACLES - DUPLEX
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Hubbell
    - c) Disallowed: None

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2. Component Characteristics:
  - a) Required:
    - 1) Provide 20A, 125V AC, extra heavy-duty specification grade 2-pole, 3-wire grounding type receptacles.
    - 2) Receptacles shall be self-grounding, back wired grounding with binding head staked terminal screws.
    - 3) Receptacles shall have a deep treaded brass center rivet to hold cover plates without rotating or stripping.
    - 4) The grounding contact shall be one piece brass and internally connected to the frame with ground terminal for external ground.
    - 5) Duplex Receptacles: Hubbell #HBL 5362 series or equal.
    - 6) Duplex Receptacles: Hubbell #HBL 5361 series or equal.
  - b) Preferred: None
  - c) Disallowed: None

### B. RECEPTACLES - GROUND FAULT CIRCUIT INTERRUPTING (GFCI)

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Hubbell
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Provide 20A, 125V AC, heavy-duty commercial grade 2-pole, 3-wire grounding GFCI receptacles.
    - 2) The GFCI receptacles shall be in conformance with UL 943 and equipped with integral solid state sensing and signaling circuitry capable of detecting and interrupting a maximum 5 milli-amp line-to-ground fault current in approximately 0.025 second.
    - 3) Device shall provide ground fault indicator, no power to face if reverse wired. Shall be equipped with trip indication, manual reset and test mechanisms.
    - 4) GFCI Receptacles: Hubbell #GF20 series or equal.
  - b) Preferred: None
  - c) Disallowed: None

### C. RECEPTACLES - ISOLATED GROUND (IG)

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Hubbell
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Provide 20A, 125V AC, specification grade 2-pole, 3-wire grounding IG receptacles.
    - 2) The IG receptacles shall conform to UL Standard #498, ANSI #C73 and NFPA 70 requirements.
    - 3) IG Receptacles: Hubbell # HBL-IG 2162 series or equal.
  - b) Preferred: None
  - c) Disallowed: None

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### D. TOGGLE SWITCHES

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Hubbell - HBL series
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Provide 20A, 120-277V AC, extra heavy-duty industrial grade toggle type switches with ground screw.
    - 2) The switch shall be quiet type with silver alloy contacts, abuse resistant handle, back and side wired with totally enclosed case.
    - 3) Single Pole Switches: Hubbell #HBL-1221series or equal.
    - 4) Three-way Switches: Hubbell #HBL-1223 series or equal.
    - 5) Illuminated (lighted handle w/load off): Hubbell #HBL-1221-IL series or equal.
  - b) Preferred: None
  - c) Disallowed: None

### E. ROCKER SWITCHES

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Hubbell - DS series
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Provide 20A, 120-277V AC, specification grade rocker type decorator style switches with ground screw.
    - 2) The switch shall be quiet type with silver alloy contacts, back and side wired with totally enclosed case.
    - 3) Single Pole Switches: Hubbell #DS120 series or equal.
    - 4) Three-way Switches: Hubbell #DS320 series or equal.
    - 5) Illuminated (lighted handle w/load off): Hubbell #DS120IL series or equal.
  - b) Preferred: None
  - c) Disallowed: None

### F. DIMMER SWITCHES - INCANDESCENT AND LOW VOLTAGE

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Lutron - Maestro series
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Provide digital fade dimmers with side touch rocker to adjust light level, 120V with minimum 1000W rating.
    - 2) Dimmer control devices shall have a linear slide control with on/off feature with built-in radio/TV interference filter.

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- 3) All standard non-dim switches mounted next to dimmers shall be matching companion type switches.
  - 4) 600W dimmers: Lutron - Maestro series Cat. # MA-600 (or MALV-600 for Low voltage dimmers) or equal.
  - 5) 1000W dimmers: Lutron - Maestro series Cat. # MA-1000 (or MALV-1000 for Low voltage dimmers) or equal.
  - b) Preferred: None
  - c) Disallowed: None
- G. DIMMER SWITCHES - FLUORESCENT
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Lutron - Maestro series
      - 2) Or equal by Crestron
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Provide digital fade dimmers with side touch rocker to adjust light level, 120-277V with 6A rating.
      - 2) Dimmer control devices shall have a linear slide control with on/off feature with built-in radio/TV interference filter.
      - 3) Dimmers shall be compatible with the type of ballast they control.
      - 4) All standard non-dim switches mounted next to dimmers shall be matching companion type switches.
      - 5) Dimmer switches shall be Lutron Maestro series dimmers Cat. # MAF-6AM series or equal.
    - b) Preferred: None
    - c) Disallowed: None
- H. OCCUPANCY SENSORS - WALL SWITCH
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Acuity Controls
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Provide dual-technology (microphonic and passive infrared) wall switches with line voltage 120-277V direct operation with heavy duty relay.
      - 2) Wall switch sensors shall be compatible with magnetic and electronic ballasts and shall be equipped with high capacity relay contacts with ratings that include tungsten loads.
      - 3) Wall switch sensors shall have a low profile design and fit flush into a designer-style wall plate.
      - 4) Sensors shall be equipped with technology to optimize automatic time delay to fit occupant usage patterns.
      - 5) Sensors shall utilize Zero Crossing circuitry to reduce stress on relay to maximize sensor life.
      - 6) Single-button wall switch sensors: Acuity Controls WSX PDT series.

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- 7) Two- button wall switch sensors: Acuity Controls WSX PDT 2P
- b) Preferred: None
- c) Disallowed: None

### I. OCCUPANCY SENSORS – CEILING/WALL MOUNTED

- 1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Acuity Controls
  - c) Disallowed: None
- 2. Component Characteristics:
  - a) Required:
    - 1) Provide dual-technology (ultrasonic and passive infrared) ceiling/wall mount sensors with SmartSet technology.
    - 2) Sensors shall operate at 24VDC and shall be furnished with control units (power pack) to provide low voltage DC power supply as required. The control unit shall be 120/277V and installed in a dedicated J-box.
    - 3) Sensors shall be capable of corner mounting to a wall or ceiling in order to eliminate detection through open doorways and outside of controlled area.
    - 4) Sensors shall be furnished with swivel mounting bracket to allow sensor to be angled for wall or ceiling mounted and easy adjustments at job site.
    - 5) All sensors controlling two circuits or two switched legs shall be furnished with additional relay unit to accomplish dual switching requirements as indicated on drawings.
    - 6) Sensors shall be capable to operate seamlessly with override wall switches.
    - 7) Sensors shall cover up to 2000 sq ft for walking motion when mounted at 10 ft and 1000 sq ft of desktop motion.
    - 8) Ceiling/Wall mount sensors: Acuity Controls CM PDT series
  - b) Preferred: None
  - c) Disallowed: None

### J. OCCUPANCY SENSORS - CEILING MOUNTED

- 1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Acuity Controls
  - c) Disallowed: None
- 2. Component Characteristics:
  - a) Required:
    - 1) Provide dual-technology (microphonic and passive infrared) ceiling mount sensors.
    - 2) Sensors shall be ceiling mounted with a flat, unobtrusive appearance and provide 360° and up to 1000 square feet coverage.
    - 3) Sensors shall operate at 24VDC and shall be furnished with control units (power pack) to provide low voltage DC power supply as required. The control unit shall be 120/277V and installed in a dedicated J-box.

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- 4) All sensors controlling two circuits or two switched legs shall be furnished with additional relay unit to accomplish dual switching requirements as indicated on drawings.
  - 5) Sensors shall be capable to operate seamlessly with override wall switches.
  - 6) Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
  - 7) Sensors shall be Airflow Tolerant and resist false activation in high airflow environments.
  - 8) Ceiling sensors: Acuity Controls CM PDT series
- b) Preferred: None
  - c) Disallowed: None

### K. WALLPLATES - METAL

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Hubbell
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Provide smooth, stainless steel plates, American Iron and Steel Institute (AISI) Type 302, 0.040" thick with satin smooth finish in all areas, except as directed by University.
    - 2) A removable plastic film shall protect coverplates during installation. Remove film at time of final acceptance.
    - 3) Provide gang type coverplates where two or more devices are installed at one location.
    - 4) Stainless steel plates: Hubbell #S series.
  - b) Preferred: None
  - c) Disallowed: None

### L. WALLPLATES - NYLON

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Hubbell
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Provide standard size, smooth, high-impact, non-conductive nylon plates with curved corners and captive screws in areas as directed by University.
    - 2) Provide gang type coverplates where two or more devices are installed at one location.
    - 3) Nylon plates: Hubbell #NP series.
  - b) Preferred: None
  - c) Disallowed: None

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### M. WALLPLATES – WEATHERPROOF COVERS

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Hubbell
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Provide weatherproof covers for each GFCI receptacle. Covers shall be gasketed, spring loaded, self-closing and suitable for use in damp and wet locations as described in UL 514 and CEC 406.
    - 2) The base plates, covers, hinge pins, spring and screws shall be all corrosion resistant die cast aluminum.
    - 3) Vertical position covers: Hubbell #WP26 series.
    - 4) Horizontal position covers: Hubbell #CWP26H series.
  - b) Preferred: None
  - c) Disallowed: None

### N. WALLPLATES – WHILE-IN-USE COVERS

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Pass & Seymour
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Provide weatherproof while-in-use covers for each GFCI receptacle. Covers shall be gasketed, spring loaded, vertically self-closing, suitable for use in damp and wet locations while a plug is inserted into the receptacle as described in CEC 406.8.
    - 2) While-in-use covers: Pass & Seymour #WIUC10 series.
  - b) Preferred: None
  - c) Disallowed: None

## 4. INSTALLATION REQUIREMENTS

### A. Required:

1. Install wiring devices in accordance with manufacturer's written instructions, as shown on the drawings and as specified herein.
2. Install devices with the vertical centerline plumb and with all edges of the device flush against the adjacent wall surfaces.
3. Receptacles:
  - a) Mount receptacles vertically with the centerline 18" above finished floor and with grounding slot at top.
  - b) Mount GFCI receptacles above counters in bathrooms and at counters within 6'-0" of sinks, whether indicated as GFCI type or not.
  - c) Receptacle shall be installed with ground prong up.
4. Switches:
  - a) Mount switches vertically with the centerline 42" above finished floor.



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- b) Ganged switches on 277 volt circuits shall have a barrier between each switch.
  - c) Provide labeling for all switches, where circuits controlled cannot be readily seen, three or more switches under a common plate.
  - d) Manual dimmers shall be installed in individual outlet boxes. Derate ganged dimmer switches as instructed by manufacturer. Do not use common neutrals for dimmed circuits.
  - e) Provide wall override switches as required or indicated on plans in conjunction with ceiling or wall mounted occupancy sensors.
5. Wallplates:
- a) Covers on pressed steel outlet boxes in furred areas, attics, etc., or exposed in mechanical equipment rooms shall be of the same material as the outlet box.
  - b) Provide wallplates for all outlet boxes, switches, receptacles, etc.
  - c) Provide coverplates that completely cover wall opening and seat against wall.
  - d) Install blank coverplates on all outlet boxes in which no device is required or installed.
  - e) Refer to Section 26 05 53 "Identification for Electrical Systems" for the labels and labeling (i.e. panel and circuit number, etc.) requirements.
6. California Electrical Code (CEC) sized (#12 minimum) bonding jumper shall connect grounded outlet box to receptacle grounding terminal on all flush mounted units.
7. All occupancy sensor locations shall be coordinated with HVAC diffuser location and room furniture. Sensors shall be located as instructed by manufacturer for optimum coverage and performance.
8. All low voltage wiring for controls, occupancy sensors, etc., shall be in conduit.
9. Refer to Section 26 05 53 "Identification for Electrical Systems" for all device and plate color requirements.
10. All receptacle locations shall be coordinated with room furniture.
- B. Preferred: None
- C. Disallowed:
- 1. Do not install in ganged boxes with other devices.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Receptacles, Switches and sensors.
- B. Documentation required:
  - 1. Onsite test results: The contractor shall perform all required testing to ensure all devices as intended and match the control scheme indicated on documents.
- C. Required testing protocols:
  - 1. Electrical testing:
    - a) Test proper polarity of all receptacles.
    - b) Test ground continuity of all wiring devices.
    - c) Test ground fault interrupting device operation.

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- d) A test report shall be included in close-out package for all receptacles in patient care areas.
- 2. Visual and mechanical inspection:
  - a) Check proper operation of all switches.
  - b) Visually inspect and replace damaged or defective devices

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 2816 ENCLOSED SWITCHES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 "Identification for Electrical Systems" and 26 24 13 "Switchboards".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to Disconnect Switches and Manual Control Switches.
    - b) All Switches shall be fully rated to withstand symmetrical short-circuit current available at terminals.
    - c) Provide all disconnect switches with devices enabling the switch to be locked in the "OFF" and/or "CLOSED" positions.
    - d) Provide 20% spare fuses in multiples of (3) per rating, minimum of one set of (3) per rating.
  - 2. Preferred: None
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. Disconnect Switches:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Square D
      - 2) Eaton
      - 3) General Electric
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:

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- 1) All disconnect switches shall be the "Heavy Duty" type and shall meet the latest edition of Federal Specification W-S-865.
  - 2) Provide switches with switchblades that are fully visible in the "OFF" position when the door is open.
  - 3) Provide switches with a quick-make, quick-break, position indicating, operating handle and mechanism and a dual cover interlock to prevent unauthorized opening of the switch door in the "ON" position or closing of the switch mechanism with the door open.
  - 4) Provide UL listed lugs; 75°C rated, for copper conductors, lugs to be front removable.
  - 5) Provide switches with hinged cover in NEMA 1 general purpose, sheet steel enclosure for dry locations and NEMA 3R weatherproof galvanized enclosures for exterior, damp or wet locations, unless otherwise noted on the Drawings.
  - 6) Provide UL listed current limiting (dual-element, time-delay) type RK5 fuses for all fused switches. All Switches shall be equipped with rejection hardware to prevent installation of all but class "R" fuses.
- b) Preferred: Finish shall be ANSI 61 gray.
  - c) Disallowed: General Duty switches.

### B. Manual Control Switches:

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Square D
    - 2) Eaton
    - 3) General Electric
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) Fractional horsepower manual control starters shall be motor rated tumbler switches, rated up to 1HP 277 VAC (1P or 2P).
    - 2) Manual starter switches shall be equipped with integral overload protection.
  - b) Preferred: None
  - c) Disallowed: None

## 4. INSTALLATION REQUIREMENTS

### A. Required:

1. Install Switches in accordance with manufacturer's written instructions.
2. Coordinate locations of switches and equipment in the field to provide code required clearances in front of switches and to insure that switches are in sight of the controller as described in CEC Article 430.
3. Mounting height shall be such that the centerline of highest operable handle does not exceed 6'-6" above finished floor.
4. Switches shall be mounted to withstand seismic forces as required per code. Securely fasten to structural members or channel support.
5. Provide construction channel and mounting hardware as required to support disconnect switch.

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6. Install manual motor starters surface mounted in equipment rooms and non-finished areas. Where installed above ceilings, access panels must be provided.
- B. Preferred: None
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Enclosed switches and manual control switches.
- B. Documentation required:
  1. Test reports: The contractor will engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations and protective devices.
- C. Required testing protocols:
  1. General:
    - a) Inspect for physical and mechanical condition.
    - b) Check tightness of all terminations/connections.
    - c) Test each switch for proper grounding

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 3213 ENGINE GENERATORS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Sections 26 05 53 "Identification for Electrical Systems", 26 05 26 "Grounding and Bonding for Electrical Systems".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to packaged engine generator set.
    - b) Engine generator assembly and accessories shall provide source of power for Level 1 applications (Level 2 applications for only optional standby installations) in accordance with NFPA 110.
    - c) The packaged engine generator set shall be complete and consist of engine generator with all parts, radiator, sound attenuated enclosure, exhaust silencer with insulation, fully rated circuit breakers, emergency power off switch, under base fuel tank, batteries, chargers and etc.
    - d) All the components, excluding the exhaust silencer and particulate filter shall be installed inside the weather-proof enclosure.
    - e) The enclosure in-take air louvers shall be located at the back of the enclosure and discharge air section shall be an acoustic turn scoop at opposite end to discharge the air in an upward direction.
    - f) The interior of enclosure shall be covered with acoustical insulation made of mineral wool and in compliance with UL Fire Hazard Ratings as per ASTM specification E-84 or latest edition.
    - g) Provide minimum of (4) two-lamp fluorescent vapor-tight fixtures with emergency battery pack option, two on each side for general enclosure interior lighting.
    - h) Provide minimum of (2) GFCI type duplex receptacles with weatherproof coverplate mounted inside the generator enclosure, one on each side.
    - i) The weather-protective sound attenuated enclosure shall be rated for 65dBA measured at 23' for all projects within 100' of any residences and 75dBA beyond 100' of any residences. The exhaust silencer shall be as

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required to attenuate overall sound level of entire package (exhaust and mechanical noise) to dBA levels stated above.

- j) The exhaust silencer shall be furnished with muffler companion flanges and flexible stainless steel exhaust fitting, suitable for horizontal orientation and sized in accordance with engine manufacturer's instructions.
  - k) Provide a rain cap or other approved means to prevent water from entering exhaust pipe.
  - l) The fuel tank shall be UL listed double-wall, under-base tank, rated for a minimum of 24-hour continuous operation or as directed by the University Representative. The fuel tank shall include Mechanical overfill prevention valve and 5 gallon spill containment with leak detection and four level sensors - high alarm, high, low and low alarm.
  - m) Provide integral 120/208V, 3phase, 4-wire panelboards as part of the generator enclosure for generators larger than 1000kW.
  - n) Provide emergency power off (EPO) switch as part of generator set controller and a remote EPO switch on the generator enclosure or as directed by local fire department.
  - o) Provide a digital generator-mounted control panel. The controller shall be a fully featured power metering and protective relaying with engine and generator control and monitoring capability. The panel shall be tied to the University BMS System and Fire Alarm System – refer to 26 0913 Power Monitoring and Control for specific alarms.
  - p) Provide a generator set that fully complies with the applicable emission regulations of the South Coast Air Quality Management District (SCAQMD) at the time it is to be commissioned and go into operation.
- 2. Preferred: None
  - 3. Disallowed: None

B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

A. Generator set:

- 1. Manufacturers:
  - a) Required (for generators smaller than 500kW):
    - 1) Caterpillar
    - 2) Cummins
    - 3) Kohler
  - b) Required (for generators 500kW and larger)
    - 1) Caterpillar
    - 2) Cummins
  - c) Preferred: None
  - d) Disallowed: All Others
- 2. Component Characteristics:
  - a) Required:
    - 1) The generator shall be ANSI/NEMA MG 1, class F, 0.8 power factor, 130°C continuous temperature rise, 3-phase, 4-pole, 60 Hz, re-connectable brushless synchronous type with brushless exciter.
    - 2) The generator shall have a permanent magnet generator (PMG) excitation in accordance with IEEE standards for 50°C rise. The PMG

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and controls shall be capable of sustaining and regulating current supplied to a 1-phase or 3-phase fault at approximately 300% of rated current for 10 seconds.

- 3) The generator shall have a digital voltage regulator (V/Hz) to match engine and generator characteristics, with voltage regulation  $\pm 1/4\%$  during steady state conditions and  $\pm 1\%$  from no load to full load. Generator output voltage drift shall not exceed  $\pm 1\%$  of rated value over ambient temperature range of 40°C to 70°C.
- 4) The governor shall be electronic Isochronous type to maintain engine speed to within 0.25% at steady state and 5% at no load to full load with recovery period of 3 seconds after sudden load changes.
- 5) The engine shall be water-cooled inline or V-type, heavy-duty 4 stroke cycle, turbocharged and after-cooled, compression ignition Diesel internal combustion engine.
- 6) Provide DC starting system with positive engagement, two starter motors with voltage in accordance with manufacturer's instruction. Include remote starting control circuit, with 'MANUAL-OFF-REMOTE' selector switch on engine-generator control panel.
- 7) Provide heavy-duty, diesel starting type lead-acid storage batteries, 24 volt DC (or matching voltage to starting system) with a capacity of not less than 190 ampere-hours at 20 hour rate. Batteries shall be low-maintenance type (1000 hours) and have a minimum of 5 year life.
- 8) Provide current limiting type battery charger designed to float at 2.17V per cell and equalize at 2.33V per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter and 120 volts AC fused input. Include alarm contacts for charger malfunction, low and high battery voltage.
- 9) Provide thermal circulation type jacket water heater with integral thermostatic control, sized to maintain engine jacket water at 90°F and suitable for operation on 208 volts AC.
- 10) The radiator shall be engine mounted with blower fan that is sized to maintain safe engine temperature in ambient temperature of 115°F.
- 11) Provide NEMA AB 1 molded case circuit breaker(s) with two-step stored energy operation on generator output with integral solid state trip unit; number and rating as required/indicated. Circuit breaker(s) shall have minimum AIC rating based on fault current analysis, be 100% rated, solid state with ground fault wired only for alarm annunciation. The breaker manufacturer shall be the same as downstream breaker in the new distribution switchboard.
- 12) The generator controller shall be equipped with customer programmable protective relaying which is used as alarm or shutdown to protect against "Under-voltage", "Over-voltage", "Under-frequency", "Over-frequency", "Over-current" and "Reverse-power". Controller shall be capable for expanded remote customer communications via Modbus RTU protocol using RS-485. Provide raceway from generator controller to University BMS connection location.
- 13) Provide flush mounted remote annunciator panel (RAP) model EMCP-3 manufactured by Caterpillar or equal.



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- 14) Provide an active Particulate Matter (DPF) Filter sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. Active DPF shall also meet the following:
- Filter manufacturer must have California Air Resource Board (CARB) verification to Level 3+ for emissions reduction.
  - Shall be a minimum of 80% porous, and shall regenerate when energized electrically, independent of exhaust temperatures
  - Shall include differential pressure sensors to initiate and control regeneration process as a function of backpressure. Backpressure must not exceed 90% of engine manufacturer's specification.
  - Shall receive power directly from the Genset and shall operate when Genset is in operation. All wiring, conduit, transformer and breaker installation shall meet NEC and be included by the Genset supplier.
  - Shall meet the following minimum requirements:
    - PM Reduction: 85%
    - Hydrocarbon reduction: 75%
    - Carbon Monoxide reduction: 90%
    - Nitrogen Dioxide reduction: 40%
  - Shall be sized to limit backpressure to a maximum of 90% of the allowable limit specified by engine manufacturer.
  - DPF(s) shall be suitable for horizontal mounting, with flanged inlet(s) and outlet(s).
  - Engine exhaust outlets shall be coupled to DPF(s) by means of adequately sized section of stainless corrugated flex. Flex connector(s) shall be flanged at both ends for mating to the engine and exhaust system.
  - Shall give operators visual notification and contact closure when:
    - Operating normally
    - Backpressure exceeds normal operation conditions.
  - Must be able to operate effectively within the engine manufacturer's recommended operating profile, while operating within the acceptable backpressure range as specified by engine manufacturer without limiting variation in engine loading levels and/or number of cold starts beyond specification by engine manufacturer.
  - Acoustic properties of DPF shall include critical grade attenuation, reducing exhaust sound pressure levels below 80dBA at 25 feet from the discharge.
- b) Preferred:
- 1) Emergency primary and secondary vents shall extend up and out of enclosure.
  - 2) Active DPF(s) shall be manufactured by Rypos. Approved equals may be considered.
- c) Disallowed:
- 1) Passive particulate matter filter

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### 4. INSTALLATION REQUIREMENTS

- A. Required:
1. Install generator set in accordance with manufacturer's written instructions, as shown on the drawings.
  2. Mount on structural steel base, supported on suitable spring-type vibration isolators sized for minimum 1" static deflection that meet the seismic requirements of the State of California.
  3. Provide a minimum of 6 to 8 inch high (or higher per anchorage and seismic calculations) concrete housekeeping pad or structural platform beneath equipment that extends maximum of 6" only above finished grade. Coordinate actual sizes of equipment base with shop drawings and extend pad or platform 6 inches in all directions beyond overall dimension of base. Provide reinforcing bars as required structurally within concrete pad to ensure proper support of equipment.
- B. Preferred:
1. Minimum 8' clearance in front of generator for air intake and 5' clearance around sides or per manufacturer's requirements.
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: generator set.
- B. Documentation required:
1. Test reports: The Independent testing agency (engaged by the contractor) and manufacturer's authorized dealer shall provide test reports for all generator components, connections/terminations, ventilation, exhaust, fuel, battery, EPOs, protective devices and etc.
  2. Provide a method of procedure to be reviewed and approved by the University's Representative for the testing tests to be performed below.
  3. At conclusion of site testing, contractor shall fill fuel tank.
- C. Required testing protocols:
1. Manufacturer's Authorized Dealer Shop tests, witnessed by the University's Representative:
    - a) Run at rated full load and 0.8 power factor for 2 hours minimum or time required to reach operating temperature.
    - b) Monitor and record the required data at 15 minute intervals for Ambient temperature, Voltage, Frequency, Ampere, Power Factor, Kilowatts, Oil & Fuel pressure, Jacket water temperature, DC volts, Date & time of day.
    - c) Monitor voltage regulation.
    - d) Verify transient and steady-state governing.
    - e) Verify single step load pickup.
    - f) Monitor engine operating parameters; coolant temperature, oil pressure and alike.
    - g) Operate safety shutdowns.

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- h) Do not use engine generator control instruments for reading load bank values. Compare load bank measured values to generator control instrument values. Calibrate generator instruments as required.
2. Field inspection and testing:
- a) Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - b) Acceptance Tests:
    - 1) Perform tests required by NFPA 110 that are additional to those specified here or as deemed necessary by manufacturer.
  - c) Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
    - 1) Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    - 2) Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    - 3) Verify acceptance of charge for each element of the battery after discharge.
    - 4) Verify that measurements are within manufacturer's specifications.
  - d) Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
  - e) System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
  - f) Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
  - g) Exhaust Emissions Test: Comply with applicable government test criteria.
  - h) Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 25%, 50%, 75%, and 100% step-load increases and 100%, 75%, 50%, and 25% step-load decreases and verify that performance is as specified. Step loads shall be performed going from from 0 to the step and then back to 0 again (example 0 load to 25% load then to 0 load). Provide graphical report of oscilloscope reading as part of test report
  - i) Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits
  - j) Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at locations shown on drawings and compare measured levels with required values.
  - k) Include the minimum pre-start checks before starting the engine: Oil & water levels, Day tank fuel level, Battery connection and charge condition, Engine control interlocks completed, Engine generator intake/exhaust obstructions, Engine room ventilation obstructions where applicable, Removal of all packing materials.

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- l) A portable resistive load bank with capacity to test emergency system load for a single generator set. Run each engine generator for a minimum of 4 hours at rated load and power factor.
  - m) Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
  - n) Monitor and record the following data at 15 minute intervals during 4 hour test: Ambient temperature, Ampere & Voltage all 3-phases, Frequency & DC volts, Oil & Fuel pressure, Jacket water & Exhaust gas temperatures, Power Factor & Kilowatts when included w/instrumentation package, Date & time of day.
  - o) Demonstrate proper operation of controls, engine shutdown and safety devices.
3. Training and Maintenance:
- a) Instruct the University's Representative in the proper use, operation and maintenance of the generator set. Train the University's personnel in the procedures to be followed checking for the source of an operational failure or malfunction.
  - b) Furnish a factory-trained engineer for a minimum of one working day to satisfy the University's personnel that the system is functioning properly.
  - c) Demonstrate to the University's Representative the change over with 100% of the emergency load on to the generator and change back to the normal state.
  - d) Training to be recorded. See Div 1 specifications.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 26 3323 CENTRAL BATTERY EQUIPMENT

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 "Identification For Electrical Systems"
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Continuously provide ac power to connected electrical system.
    - b) Automatic Operation:
      - 1) Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, through rectifier-charger and inverter, with battery connected in parallel with rectifier-charger output.
      - 2) Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, battery supplies constant, regulate, inverter ac power output to the load without switching or disturbance.
      - 3) When power is restored at normal supply terminals of system, controls automatically synchronize inverter with the external source before transferring the load. Rectifier-charger then supplies power to the load through the inverter and simultaneously recharges battery.
      - 4) If battery becomes discharged and normal supply is available, rectifier-charger charges battery. When battery is fully charged, rectifier-charger automatically shifts to float charge mode.
      - 5) If any element of central battery inverter system fails and power is available at normal supply terminals of system, static bypass transfer switch transfers the load to normal ac supply circuit without disturbance or interruption of supply.
      - 6) If a fault occurs in system supplied by central battery inverter and current flows in excess of the overload rating of central battery inverter system, static bypass transfer switch operates to bypass fault current to normal ac supply circuit for fault clearing.

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- 7) h. When fault has cleared, static bypass transfer switch returns the load to central battery inverter system.
  - 8) If battery is disconnected, central battery inverter continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.
  - c) Manual Operation:
    - 1) a. Turning inverter off causes static bypass transfer switch to transfer the load directly to normal ac supply circuit without disturbance or interruption.
    - 2) b. Turning inverter on causes static bypass transfer switch to transfer the load to inverter.
  - d) Maximum Acoustical Noise: 58dB, "A" weighting, emanating from any UPS component under any condition of normal operation, measured 36 inches from nearest surface of component enclosure.
  - e) Service Conditions
    - 1) Environmental Conditions: Inverter system shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
      - 2) Ambient Temperature for Electronic Components: 32 to 98 deg F.
      - 3) Relative Humidity: 0 to 95 percent, non-condensing.
      - 4) Altitude: Sea level to 4000 feet.
  - f) Examination
    - 1) Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance.
    - 2) Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
    - 3) Examine roughing-in for electrical connections to verify actual locations of connections before installation.
    - 4) Proceed with installation only after unsatisfactory conditions have been corrected.
2. Preferred:
    - a) None
  3. Disallowed:
    - a) Switchboards with series-connected rating with integral or remote upstream overcurrent protective devices.
    - b) Tapered bus is not permitted. The neutral bus shall be of equivalent ampacity as the phase bus bars for 4-wire systems.
- B. Quality Assurance requirements beyond standard 1 year warranty:
1. Batteries:
    - a) Full warranty: Three years minimum.
    - b) Prorated: Seven years minimum.

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### 3. PRODUCT REQUIREMENTS

#### A. Central inverters:

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) Meyers
    - 2) TrippLite
    - 3) Dual Lite
  - c) Disallowed: Others
2. Component Characteristics:
  - a) Required:
    - 1) Description: Solid-state type, with the following operational features:
    - 2) Automatically regulate output voltage to within plus or minus 5 percent.
    - 3) Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load at unit power factor over the operating range of battery voltage.
    - 4) Output Voltage Waveform of Unit: Sine wave with maximum 10 percent THD throughout battery operating-voltage range, from no load to full load.
    - 5) Output Protection: Current-limiting and short-circuit protection.
    - 6) Output Breakers: Normally-On distribution breakers shall be provided for life safety and optional stand-by loads. No branch circuit breakers shall originate directly from Inverter.
    - 7) Surge Protection: Panelboard suppressors specified in Section 26 43 13.
    - 8) Maintenance Bypass: Internal or external make-before-break switch.
    - 9) Overload Capability: 110 percent for 10 minutes; 150 percent surge.
    - 10) Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.
    - 11) Battery Charger: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.
    - 12) Batteries: Standard, valve-regulated, recombinant, lead-calcium, wet-cell batteries capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.
    - 13) Enclosures: NEMA 250, Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch. Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.
    - 14) Seismic Requirements: Central battery inverter assemblies, subassemblies, components, fastenings, supports, and mounting and anchorage devices shall be designed and fabricated to withstand seismic forces. The term "withstand" is defined in the "Manufacturer Seismic Qualification Certification" Paragraph in Part 1 "Informational Submittals" Article.
  3. Control and Indication:
    - a) Group displays, indications, and basic system controls on common control panel on front of central battery inverter enclosure.

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- b) Minimum displays, indicating devices, and controls shall include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms shall include an audible signal and a visual display.
    - 1) Quantitative Indications: Input voltage, each phase, line to line; Input current, each phase, line to line; system output voltage, each phase, line to line; system output current, each phase; system output frequency; DC bus voltage; battery current and direction (charge/discharge); elapsed time-discharging battery.
    - 2) Basic Status Condition Indications: Normal operation; Load-on bypass; Load-on battery; Inverter off; Alarm condition exists.
    - 3) Alarm Indications: Battery system alarm; Control power failure; Fan failure; Overload; Battery-charging control faulty; Input overvoltage or undervoltage; approaching end of battery operation; battery undervoltage shutdown; inverter fuse blown; inverter transformer overtemperature; inverter overtemperature; static bypass transfer switch overtemperature; inverter power supply fault; inverter output overvoltage or undervoltage; system overload shutdown; inverter output contactor open; inverter current limit.
    - 4) Controls: inverter on-off; start; battery test; alarm silence/reset; output-voltage adjustment;
  - c) Dry-form "C" contacts shall be available for remote indication of the following conditions:
    - 1) Inverter on battery.
    - 2) Inverter on-line.
    - 3) Inverter load-on bypass.
    - 4) Inverter in alarm condition.
    - 5) Inverter off (maintenance bypass closed).
  - d) Include the following minimum array:
    - 1) Ready, normal-power on light.
    - 2) Charge light.
    - 3) Inverter supply load light.
    - 4) Battery voltmeter.
    - 5) AC output voltmeter with minimum accuracy of 2 percent of full scale.
    - 6) Load ammeter.
    - 7) Test switch to simulate ac failure.
  - e) BAS Interface: BACnet IP.
  - f) Enclosure: Steel, with hinged lockable doors, suitable for floor mounting. Manufacturer's standard corrosion-resistant finish.
4. Optional Features
- a) Maintenance Bypass/Isolation Switch: Switch is interlocked so it cannot be operated unless static bypass transfer switch is in bypass mode. Switch provides manual selection among the following three conditions without interrupting supply to the load during switching:
    - 1) Full Isolation: Load is supplied, bypassing central battery inverter system. Normal ac input circuit, static bypass transfer switch, and central battery inverter load terminals are completely disconnected from external circuits.
    - 2) Maintenance Bypass: Load is supplied, bypassing central battery inverter system. Central battery inverter ac supply terminals are



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- energized to permit operational checking, but system load terminals are isolated from the load.
- 3) Normal: Normal central battery inverter ac supply terminals are energized and the load is supplied either through static bypass transfer switch and central battery inverter rectifier charger and inverter or through battery and inverter.
5. Output Distribution Sections
    - a) Panelboard: Comply with Section 26 24 16 except provide assembly integral to equipment cabinet.
  6. System Monitoring and Alarms
    - a) Remote Status and Alarm Panel: Labeled LEDs on panel faceplate shall indicate five basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.
    - b) Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.
    - c) Provisions for Remote Computer Monitoring: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in Part 2 "Control and Indication" Article. Remote computer and connecting signal wiring will be provided by Owner. Include the following features:
      - 1) Connectors and network interface units or modems for data transmission via RS-232 link.
      - 2) Software shall be designed to control and monitor inverter system functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of reports. Include capability for storage and analysis of power-line transient records. Software shall be compatible with requirements in Section 26 09 13 and the operating system and configuration of Owner-furnished computers.
    - d) Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms. Annunciation of Alarms: At inverter system control panel.
    - e) Battery-Cycle Warranty Monitoring: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring charge-discharge cycle history of batteries covered by cycle-life warranty.
      - 1) 1. Basic Functional Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on integral LCD.
      - 2) 2. Additional monitoring functions and features shall include the following: Measuring and recording of total voltage at battery terminals; providing alarm for excursions outside proper float voltage level; monitoring of ambient temperature at battery and initiating an alarm if temperature deviates from normally acceptable range; keypad on device front panel provides access to monitored data using front panel display; Alarm contacts arranged to provide remote alarm for battery discharge events, abnormal temperature, abnormal battery voltage or temperature; Memory device to store recorded data in nonvolatile electronic memory; RS-232 port to permit downloading of data to a portable personal computer; modem to

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make measurements and recorded data accessible to remote personal computer via telephone line. Computer will be provided by Owner.

7. Source Quality Control
  - a) Factory test complete inverter system, including battery, before shipment. Include the following:
    - 1) Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
    - 2) Full-load test.
    - 3) Transient-load response test.
    - 4) Overload test.
    - 5) Power failure test.
  - b) Observation of Test: Give 14 days' advance notice of tests and provide access for Owner's representative to observe tests at Owner's option.
  - c) Report test results. Include the following data:
    - 1) Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
    - 2) List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
    - 3) List of instruments and equipment used in factory tests.

## 4. INSTALLATION REQUIREMENTS

- A. Required:
  1. Install system components on concrete base and attach by bolting.
    - a) Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 26 05 48 for seismic-restraint requirements.
    - b) Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 3 inches in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Section 26 05 29.
    - c) Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    - d) Install anchor bolts according to anchor-bolt manufacturer's written instructions.
    - e) Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03.
  2. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
  3. Connections
    - a) Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.
    - b) Ground equipment according to Section 26 05 26.

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- 1) Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
  - c) Connect wiring according to Section 26 05 19.
- B. Preferred:
1. None.
- C. Disallowed:
1. None.

### 5. EVALUATION or COMMISSIONING

- A. Field Quality Control
1. Perform tests and inspections and prepare test reports.
    - a) Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
  2. Tests and Inspections:
    - a) Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
    - b) Test manual and automatic operational features and system protective and alarm functions.
    - c) Test communication of status and alarms to remote monitoring equipment.
    - d) Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications. Certify compliance with test parameters.
    - e) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  3. Remove and replace malfunctioning units and retest as specified above.
- B. Start Up Service
1. Engage a factory-authorized service representative to perform startup service.
  2. Verify that central battery inverter is installed and connected according to the Contract Documents.
  3. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
  4. Complete installation and startup checks according to manufacturer's written instructions.
- C. Adjusting and Cleaning
1. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
  2. Install new filters in each equipment cabinet within 14 days from date of Substantial Completion.
- D. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery inverters. Refer to Division 01.

# USC DESIGN GUIDELINES

END OF DOCUMENT

# USC DESIGN GUIDELINES

## 26 3623 AUTOMATIC TRANSFER SWITCHES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 “Identification for Electrical Systems” and Section 26 09 13 “Electrical Power Monitoring and Control”.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to Automatic Transfer & bypass-isolation Switches (ATS) used in conjunction with emergency backup generators.
    - b) All ATSS shall conform to the requirements of UL 508 & 1008, NFPA 70 & 110, NFPA 99 (applicable for health care facilities only), IEEE 241 & 446 and NEMA ICS10 (Part 1) standards.
    - c) ATSS used for fire pumps shall conform to the requirements of NFPA 20.
    - d) All ATSS shall be a combination Automatic Transfer and Bypass/Isolation switch unless otherwise noted:
      - 1) The Automatic Transfer switches and associated Bypass/Isolation switch shall have identical electrical ratings.
      - 2) The Bypass/Isolation switch shall provide manual bypass of the load to either source and permit isolation of the Automatic Transfer switch from all source and load conductors.
    - e) All ATSS shall be open-transition type.
    - f) The Bypass/Isolation switches shall be load-break type.
  - 2. Preferred:
    - a) None
  - 3. Disallowed:
    - a) Automatic Transfer switches with overlapping neutral.
    - b) Automatic Transfer switches which cannot be completely withdrawn when isolated by Bypass/Isolation operation.
- B. Quality Assurance requirements beyond standard 1 year warranty:

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### 3. PRODUCT REQUIREMENTS

#### A. AUTOMATIC TRANSFER SWITCH WITH BYPASS/ISOLATION OPERATION

1. Manufacturers:
  - a) Required: No requirements
  - b) Preferred:
    - 1) ASCO, 7000 series
    - 2) Russelectric, RTS-03 series
    - 3) GE/Zenith
    - 4) CAT
    - 5) Cummins
  - c) Disallowed: None
2. Component Characteristics:
  - a) Required:
    - 1) The combination Automatic Transfer Bypass/Isolation switch shall be mounted in a single enclosure. Both units shall be bussed together to provide a complete pre-tested assembly. The Automatic Transfer switch shall be completely isolated from the Bypass/Isolation switch by means of insulating barriers and separate access doors.
    - 2) All bus bars shall be silver plated copper. All bus bars shall be formed, cut and punched prior to silver plating. The neutral bus bars where required shall be fully rated.
    - 3) For all 3-phase, 4-wire systems, utilizing ground fault protection, a true 4-pole switch shall be supplied with all four poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.
    - 4) AUTOMATIC TRANSFER SWITCH:
      - i) The Transfer switch unit shall be double throw, electrically operated and mechanically held. The electrical operators shall be momentarily energized and connected to the transfer mechanism with a minimum contact-to-contact transfer time. The switch shall be mechanically interlocked to ensure only one of two possible positions "Normal or Emergency".
      - ii) The switch shall be positively locked and unaffected by voltage variations, short circuit currents, or momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.
      - iii) All main contacts shall be silver composition. Switches rated 800 amperes and above shall have segmented blow-on construction for high withstand current capability and be protected by separate arcing contacts.
      - iv) Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

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- v) All switches shall be equipped with a safe external manual operator with the same contact to contact transfer speed as the electrical operation. The external manual operator shall be safely operated from outside the transfer switch enclosure while the enclosure door is closed.
- 5) BYPASS/ISOLATION SWITCH:
  - i) Bypass/Isolation switches shall provide a safe and convenient means for manually bypassing and isolating the Automatic Transfer switch, regardless of the position or condition of the Automatic Transfer switch, with the ability to be used as an emergency backup system in the event the transfer switch should fail. In addition, the Bypass/Isolation switch shall be utilized to facilitate maintenance and repair of the Automatic Transfer switch.
  - ii) A 2-way Bypass/Isolation switch shall provide manual bypass of the load to either source and permit isolation of the Automatic Transfer switch from all source and load power conductors. All main contacts shall be manually driven. The switching mechanism shall provide "Quick-Break," "Quick- Make" operation of the contacts.
  - iii) All main contacts and operating linkages of the Bypass/Isolation switches shall be identical to the Automatic Transfer switches except that the operation shall be manual. The Bypass/Isolation switch shall have the same electrical ratings of ampacity, voltage, short circuit withstand rating and temperature rise capability as the associated Automatic Transfer switch.
  - iv) Separate bypass and isolation handles shall be provided for clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door.
  - v) The only field installed power connections shall be at the incoming and load terminals of the Bypass/Isolation switch.
  - vi) Control components and wiring shall be front accessible. All control wiring shall be provided with disconnect plugs. All control wire terminations shall be identified with tubular sleeve type markers.
  - vii) Indicating lights or mechanical indicators shall be provided to show the Bypass/Isolation switches in the bypass position and in the fully isolated position. Positive sequencing of all contacts, with no possible intermediate position shall be accomplished through manual operators from a dead front location.
  - viii) Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make-before-break contacts). Designs that disconnect the load when bypassing are not acceptable. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." The operating speed of the bypass contacts shall be the same as the associated Transfer switch and shall be independent of the speed at which the manual handle is operated. In the "Automatic" mode, the bypass contacts shall be

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out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.

- ix) The isolation handle shall provide (3) operating modes: "Closed," "Test," and "Open." The "Test" mode shall permit testing of the entire emergency power system, including the Automatic Transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the Automatic Transfer switches from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the Automatic Transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.
  - x) When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.
  - xi) The primary bus work of the draw-out Automatic Transfer switch shall be connected to the stationary bus stabs in the freestanding cubicle by silver plated segmented, self aligning, primary disconnect fingers to facilitate proper alignment between the removable draw-out when the Automatic Transfer switch is withdrawn and shall be available for inspection without disturbing or de-energizing the main bus
  - xii) All necessary controls shall be provided to ensure that the "Engine Run" circuit remains closed when the switch is in the "Bypass-to-Emergency" position, even though the associated Transfer switch is in the "Normal" position or completely removed from the enclosure.
    - a. Preferred:
      - i) None
    - b. Disallowed:
      - i) ATs using circuit breakers, contactors or parts thereof which have not been intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- 6) ATs that cannot be completely withdrawn when isolated.

### B. MICROPROCESSOR CONTROL MODULE:

#### 1. Required:

- a) All Transfer switches shall be equipped with a Microprocessor Controller with a Power Supply Module, CPU and I/O Modules for all voltage and ampere ratings. The controller shall be capable of either Serial and Ethernet communications.
- b) The controller shall be connected to the Transfer switch through an interconnecting wiring harness. Interfacing relays shall be provided to isolate the controller from abnormal voltages applied to any and all customer input and output wiring terminals. The wiring harness shall include a keyed disconnect plug to enable the control module to be disconnected from the transfer switch for routine maintenance.
- c) All customer connections shall be wired to a common terminal block to simplify field-wiring connections.



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- d) The control module shall be completely enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance.
- e) Sensing and control logic shall be provided on plug-in printed circuit boards for maximum reliability. Interfacing relays shall be industrial control grade plug-in type with dust covers. All relays shall be identical to minimize the number of unique parts.
- f) The controller shall contain voltage sensing modules capable of direct single phase or three phase sensing of each source from 120VAC to 600VAC. The voltage sensing shall be true RMS type and shall be accurate to  $\pm 1\%$  of nominal voltage. The frequency sensing shall be accurate to  $\pm 0.2\%$ . The panel operating temperature range shall be  $-4^{\circ}\text{F}$  to  $140^{\circ}\text{F}$  and storage from  $-67^{\circ}\text{F}$  to  $185^{\circ}\text{F}$ .
- g) A color LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port.
- h) The control panel shall meet or exceed the voltage surge withstand capability in accordance with IEEE Standard 472 (ANSI C37.90A-1974) and the impulse withstand voltage test in accordance with the proposed NEMA Standard ICS 1-109.
- i) The control module shall meet the requirements of Section 26 09 13 Electrical Power Monitoring and Control for connection to the University's building management system.

- 2. Preferred: None
- 3. Disallowed: None

### C. OPERATION:

- 1. Required:
  - a) Voltage, Frequency and Phase Rotation Sensing:
    - 1) Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout and trip setting capabilities (values shown as % of nominal unless otherwise specified):

Parameter	Sources	Dropout / Trip	Pickup / Reset
Under-voltage	N+E,3 $\phi$	70 to 98%	85 to 100%
Over-voltage	N+E,3 $\phi$	102 to 115%	2% below trip
Under-frequency	N+E,3 $\phi$	85 to 98%	90 to 100%
Over-frequency	N+E,3 $\phi$	102 to 110%	2% below trip
Volt unbalance	N+E,3 $\phi$	5 to 20%	1% below dropout

- 2) Repetitive accuracy of all settings shall be within  $\pm 0.5\%$  over an operating temperature range of  $-4^{\circ}\text{F}$  to  $140^{\circ}\text{F}$ .
- 3) Settings shall be adjustable in 1% increments either through the keypad, USB port or remotely via communications.
- 4) The controller shall monitor phase rotation of both sources and inhibit transfer if both sources are not the same phase rotation (ABC or CBA).

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- 5) Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.
- b) Time Delays:
  - 1) The controller shall include an adjustable time delay of 0-6 seconds to momentarily override normal source power outages and to delay engine starting. The time delay shall be expandable up to 60 minutes if an external 24VDC power supply is provided for ATS control.
  - 2) The controller shall include an adjustable 0-60 minute time delay - Transfer to Emergency, factory set at 0 seconds.
  - 3) The controller shall include an adjustable 0-60 minute time delay - Transfer to Normal on Source Fail time delay, factory set at 15 minutes.
  - 4) The controller shall include a time delay – Transfer To Normal on Test time delay adjustable 0-60 minutes, factory set at 0. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.
  - 5) The controller shall include a time delay - Engine Cool Down adjustable 0-60 minutes, factory set at 5 minutes.
  - 6) A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:
    - i) Prior to transfer only.
    - ii) Prior to and after transfer.
    - iii) Normal to emergency only.
    - iv) Emergency to normal only.
    - v) Normal to emergency and emergency to normal.
    - vi) All transfer conditions or only when both sources are available.
  - 7) All time delays shall be adjustable in 1second increments, except the extended parallel time, which shall be adjustable in .01 second increments. All time delays shall be adjustable via the graphical display, the front USB port or configuration software using the USB, serial or Ethernet communications port.
- c) Additional Features:
  - 1) Test Switch: A 2 or 3 position test switch (key-operated or password protected) shall be provided either as part of the controller or separately to simulate normal power failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.
  - 2) Engine Start Signal: A SPDT contact, rated 5A @ 30VDC shall be provided to start the engine generator in the event of a normal source outage. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
  - 3) ATS Position Signal: Auxiliary source connected contacts rated 10A @ 120VAC or 250VAC shall be provided to signal when the ATS is connected to each source. One contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.

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- 4) Source Connected LED's: LED indicating lights shall be provided; "Green" to indicate when the ATS is connected to the normal feed "Red" to indicate when the ATS is connected to the emergency feed.
  - 5) Source Availability LED's: LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources.
  - 6) Commit/No-Commit Transfer Selector: The controller shall include a programmable selector to configure the controller to commit to transferring the load to emergency (or not) in the event the normal source returns prior to the generator being ready to accept load.
  - 7) ATS/Engine Exerciser: The controller shall include a user configurable engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. Each event shall be configurable for Test "with Load" and "without Load". Each event shall include user adjustable start time, date and test duration. All time and date settings shall be stored in non-volatile memory. The controller shall include full programmability for daylight savings time.
  - 8) In-phase Monitor: An in-phase monitor shall be built-in to the ATS for transfer and retransfer of motor loads so that inrush currents do not exceed normal starting currents. The monitor shall compare the phase relationship and frequency difference between the normal and emergency sources and permit transfer the first time the sources are within 15 electrical degrees and only if transfer can be accomplished within 60 electrical degrees as determined by monitoring the frequency difference. In-phase retransfer shall be accomplished if both sources are within 2 Hz of nominal frequency and 85% or more of nominal voltage.
  - 9) Auto/Manual Selector: The controller shall be capable of accepting a normally open contact that will allow the Transfer switch to function in a non-automatic mode using an external control device.
  - 10) Inhibit Transfer Signals: The controller shall be capable of accepting transfer control inputs that inhibit transfer of the ATS to either source.
  - 11) Diagnostics: The controller shall contain self and system diagnostic screens for the purpose of detecting and troubleshooting abnormal system events.
  - 12) System Status: The controller LCD display shall include a "System Status" screen that is readily accessible and displays a clear description of the active operating sequence and switch position.
  - 13) Event/Data logger: The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power failure.
  - 14) Communications Interface: The controller shall be capable of interfacing via serial or Ethernet communications ports integral to the controller with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem. Standard software specific for transfer switch applications shall allow for the monitoring, control and setup of parameters. Both serial and Ethernet communication shall be Modbus open protocol.
- d) Optional Accessories Required:
- 1) Communications Module: The controller shall be capable of supporting Serial (RS485) or Ethernet (TSP/IP) shall be installed in

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the ATS controller to enable communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices. (For Ethernet communication, a Serial to Ethernet converter equal to ASCO Accessory 72E or 72SW shall be provided unless controller has Ethernet communication capability).

- 2) External Power Supply: The controller shall be capable of being connected to an external 24VDC power supply to permit full operation and communications of the controller when both sources are de-energized (ASCO Accessory 1G or equal).
  - 3) Transfer Test/Retransfer Time Delay Bypass Selector: A 3-position selector, spring return Left, maintained Right. Test position (maintained) simulates a normal source failure with override retransfer to normal in the event of any Emergency source failure (ASCO Accessory 5L or equal).
  - 4) Selective Load Disconnect: Selective load disconnect control contacts (2 provided) which operate with time delay prior to and/or after load transfer and retransfer (ASCO Accessory 31Z or equal).
  - 5) Power Manager: The ATS shall be furnished with power manager for monitoring ATS load. It shall consist of Electronic Access Module (EAM), which measures voltage frequency and current. The power manager uses these measurements to calculate power, energy parameters and power factor. The (EAM) can communicate data to host devices that are part of ATS communications systems (ASCO Accessory 75L/85L or equal).
2. Preferred: None
  3. Disallowed: None

### D. WITHSTAND AND CLOSE RATINGS:

1. Required:
  - a) All switches shall be UL listed in accordance with UL 1008 for 3-cycle close and withstand ratings. The Automatic Transfer and Bypass/Isolation switch shall be tested as a complete connected unit.
  - b) All switches shall be fully rated to withstand the available "rms symmetrical" short circuit current at the switch terminals without any internal or external overcurrent protective devices. Separate arcing contacts with magnetic blowouts shall be provided on all Transfer switches.
  - c) Minimum UL listed close & withstand ratings at 480VAC shall be as follows:
    - 1) 100 – 400A switches shall be 42kA.
    - 2) 600 – 800A switches shall be 65kA.
    - 3) 1000 – 1200A switches shall be 85kA.
    - 4) 1600 – 4000A switches shall be 100kA.
  - d) Larger size ATSS shall be utilized to meet the required close & withstand ratings that are higher than the listed values above.
2. Preferred: None
3. Disallowed: ATSS that are not tested and labeled with 3-cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.

### E. MISCELLANEOUS REQUIREMENTS:

1. Required:

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- a) Provide additional auxiliary dry contacts from the ATS to each elevator machine room for projects that elevators are on emergency power:
    - 1) One dry contact to open when normal power fails and emergency standby power becomes available and to close when normal power returns to signal elevator controllers.
    - 2) One dry contact to open on emergency power and to close 30 to 60 seconds prior to transfer back to normal power to allow elevators to come to rest prior to normal power resumption.
  - b) Sensing and control logic shall be provided on plug-in printed circuit boards for maximum reliability. Interfacing relays shall be industrial control grade plug-in type with dust covers. All relays shall be identical to minimize the number of unique parts.
- 2. Preferred: None
  - 3. Disallowed: None

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Installation shall conform to the requirements of CEC and manufacturer's recommendations
  - 2. ATSs shall be anchored and braced to withstand seismic forces as required.
  - 3. Tighten electrical connectors and terminals; including screws and bolts, in accordance with equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturers torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque specified in NETA Standard Tables.
- B. Preferred: None
- C. Disallowed: None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Automatic Transfer Switches.
- B. Documentation required:
  - 1. Test reports: The contractor shall engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations, controls and settings.
- C. Required testing protocols:
  - 1. ATS assemblies:
    - a) Inspect physical and mechanical condition.
    - b) Verify tightness of all terminations/connections, including controls wiring.
    - c) Inspect all bolted electrical connections for high resistance per NETA.
    - d) Perform manual transfer operation.
    - e) Verify positive mechanical interlocking between both power sources.
  - 2. Electrical Tests:

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- a) The contractor shall furnish labor, equipment and incidentals for and shall perform all field tests in accordance to NETA ATS 7.22-3 and as described below. Work affected by deficiencies shall be completely retested at the Contractor's expense. The manufacturer's factory representative shall assist the Contractor with the field test and inspection. Field tests shall include the following:
  - 1) Set all adjustable timers and control and protective devices.
  - 2) Simulate power failure and demonstrate complete ATS operation. Contractor shall show by demonstration in service that all the ATSS are in good operating condition.
  - 3) Conduct 15 minute load run utilizing portable load banks.
  - 4) The switch shall be subjected to a dielectric strength test per NEMA Standard ICS1-109.21.
- 3. All production units shall be subjected to the following factory tests:
  - a) The complete combination Automatic Transfer Bypass/Isolation switch assembly shall be tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
  - b) During 3-cycle closing & withstand tests per UL 1008, there shall be no contact welding or damage. The 3-cycle test shall be performed without the use of current limiting fuses. The tests shall verify that contact separation has not occurred, and there is contact continuity across all phases.
  - c) When conducting temperature rise tests to UL-1008, the manufacturer shall include post-endurance temperature rise tests to verify the ability of the ATS to carry full rated current after completing the overload and endurance tests.
  - d) Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards and withstand current ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of submittal, shall be included in the certification.

**END OF DOCUMENT**

# FACILITY DESIGN GUIDELINES

## 26 5100 INTERIOR LIGHTING DESIGN REQUIREMENTS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to Lighting.
    - b) The following information represents the starting point for all lighting designs. Fixture substitutions are acceptable. Cut sheets for substituted fixtures are to be provided to USC, prior to specifying, for approval.
    - c) The following guidelines are in no way meant to be a comprehensive list of all acceptable and unacceptable fixtures and standards. Exceptions may be made on a project basis by USC.
    - d) Both ceiling and wall types of occupancy sensors are acceptable as applicable for the space being controlled.
    - e) Areas that are larger than the occupancy sensor's standard coverage shall have several sensors.
    - f) Electrical and mechanical rooms shall not be controlled via occupancy sensors.
    - g) Path of egress shall have code required emergency lighting.
    - h) Proposed lighting fixtures shall be submitted to USC prior to specifying.
    - i) Dimming systems in lecture halls, auditoriums and conference rooms shall be an Architectural type preset set system.
    - j) Architectural dimming systems shall have graphic interface with ability to save preset scenes and communicate with audio / visual systems.
  - 2. Preferred:
    - a) General Offices – 2x2 or 2x4 troffer.
    - b) General Classrooms - 2x2 or 2x4 troffer.
    - c) Dimming
      - 1) General – Digital room controls.
      - 2) Lecture Halls – Digital dimming system.
    - d) Recommended Uniform Light Levels per the latest edition of IESNA standards.

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3. Disallowed:
  - a) Fluorescent
  - b) Incandescent
  - c) HID Lamps
  - d) Halogen
- B. Quality Assurance requirements beyond standard 1 year warranty:
  1. 5 Years: All lighting fixtures.

### 3. PRODUCT REQUIREMENTS

- A. Lighting and Controls:
  1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
    - c) 2x2 or 2x4 troffer.
      - 1) Lithonia 2BLT series
    - d) 2x2 or 2x4 troffer.
      - 1) Lithonia 2BLT series
    - e) Dimming
      - 1) General – Acuity Brands (nLight)
      - 2) Lecture Halls – Fresco with nLight digital controls
    - f) Occupancy Sensors / Room Controls
      - 1) Acuity Brands (nLight)
    - g) Building Networked Controls
      - 1) Acuity Brands (nLight)
    - h) Exit Signs
      - 1) New buildings: Lithonia Edge-Lit with green lettering. Two circuit type.
      - 2) Existing buildings: Lithonia Edge-Lit with green lettering or Quantum white thermal plastic with green lettering to match existing. Two circuit type.
    - i) Disallowed:
      - 1) Lutron Grafik Eye
  2. Component Characteristics:
    - a) Required:
      - 1) Occupancy sensors shall be dual technology type.
      - 2) Lighting fixtures shall be high efficacy LED.
      - 3) Lighting fixtures shall be dimmable to 10% minimum.
      - 4) Color temperature for interior lights shall be 3500K and minimum 85 CRI.
      - 5) Color temperature for exterior lights shall be 2200K and minimum 85 CRI.
      - 6) Exit signs shall accept dual feed where the building has a separate emergency source.
    - b) Preferred:
      - 1) None
    - c) Disallowed:
      - 1) None



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### 4. INSTALLATION REQUIREMENTS

- A. Required:
1. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
  2. Supports: Sized and rated for luminaire weight.
  3. Attach supports to structural members. Do not attach direct to gypsum board.
  4. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
  5. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  6. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
  7. Layout sensors with an unobstructed line of sight to the task areas.
  8. Adjust time and sensitivity per type of area and task being monitored.
  9. Install audio / visual interfaces in audio / visual cabinet and connect to lighting control system. Connection to audio / visual system by audio / visual system installer.
  10. Lighting control devices above hard-lid ceilings shall be located and shall be accessible at ceiling access panel.
- B. Preferred:
1. None
- C. Disallowed:
1. None

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:
1. Lighting Fixtures
  2. Lighting Controls
- B. Documentation required:
1. Test reports: The contractor will engage a qualified Independent testing and inspecting agency to perform field tests/inspections and provide reports for all connections/terminations.
  2. As built drawings with locations of all fixtures, devices and barcode locations.
  3. Warranty information:
    - a) Manufacturer
    - b) Where lighting fixtures were purchased.
    - c) Date when warranty begins and expires.
  4. Each project must be signed off by the USC Electrical Program Manager or Lighting Project Manager
  5. Project's software file shall be delivered to the USC Electrical Program Manager or Lighting Project Manager.
  6. During commissioning for nLight Controls, access to the lighting control system must be shared to USC Lighting Project Manager's or Electrical Program Manager's nLight account

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7. Labeling in software shall identify items by building acronym code and room numbers.
  8. Provide 2% attic stock for all lighting fixtures and control components. Minimum of 1 each.
- C. Required testing protocols:
1. Lighting Fixtures and Controls:
    - a) Inspect for physical and mechanical condition.
    - b) Check tightness of all terminations/connections.
    - c) Check locations, line of sight and type of sensor.
    - d) Set occupancy control's hold and delay time must be set to maximum time allowance per applicable energy code, and set to maximum sensitivity.
    - e) Adjustable fixtures shall be aimed in the presence of the USC representative.
    - f) Program dimming system's scenes and presets in conjunction with audio / visual installer. Demonstrate functions to USC.

**END OF DOCUMENT**

# USC BASIS OF DESIGN

## 26 5613 LIGHTING POLES AND STANDARDS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 05 53 "Identification for Electrical Systems".
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) For purpose of this guideline, this section pertains to exterior lighting poles
    - b) Furnish products listed and classified by UL, CEC, and LA City recognized/approved agency as suitable for purpose specified and indicated.
  - 2. Preferred: None
  - 3. Disallowed: None
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. 9 Foot Pole:
  - 1. Manufacturers:
    - a) Required: WJ Whatley
    - b) Preferred: None
    - c) Disallowed: All Others
  - 2. Component Characteristics:
    - a) Part number WDN2476-9(2)
- B. 9 Foot Pole - Twin Arms:
  - 1. Manufacturers:
    - a) Required:
      - 1) Pole: WJ Whatley
      - 2) Fixtures: Philips Hadco
    - b) Preferred: None

## USC BASIS OF DESIGN

- c) Disallowed: All Others
  - 2. Component Characteristics:
    - a) Pole part number WDN2476-9(2)
    - b) Fixture part number L-7842-F
- C. 12 Foot Pole:
  - 1. Manufacturers:
    - a) Required: WJ Whatley
    - b) Preferred: None
    - c) Disallowed: All Others
  - 2. Component Characteristics:
    - a) Pole part number WDN2470-12
- D. 12 Foot Pole with HID Head:
  - 1. Manufacturers:
    - a) Required:
      - 1) Pole: WJ Whatley
      - 2) Fixture: Philips Hadco
    - b) Preferred: None
    - c) Disallowed: All Others
  - 2. Component Characteristics:
    - a) Pole part number WDN2470-12
    - b) Fixture part number L-7842-F
- E. 12 Foot Pole - Twin Arms:
  - 1. Manufacturers:
    - a) Required:
      - 1) Pole: WJ Whatley
      - 2) Fixture: Philips Hadco
    - b) Preferred: None
    - c) Disallowed: All Others
  - 2. Component Characteristics:
    - a) Pole part number WDN2470-12
    - b) Fixture part number L-7842-F
- F. 14 Foot Pole:
  - 1. Manufacturers:
    - a) Required: WJ Whatley
    - b) Preferred: None
    - c) Disallowed: All Others
  - 2. Component Characteristics:
    - a) Pole part number WDN2470-14
- G. HID Head
  - 1. Manufacturers:
    - a) Required: Philips Hadco
    - b) Preferred: None
    - c) Disallowed: All Others
  - 2. Component Characteristics:
    - a) Part number L7842F-BRZ

## USC BASIS OF DESIGN

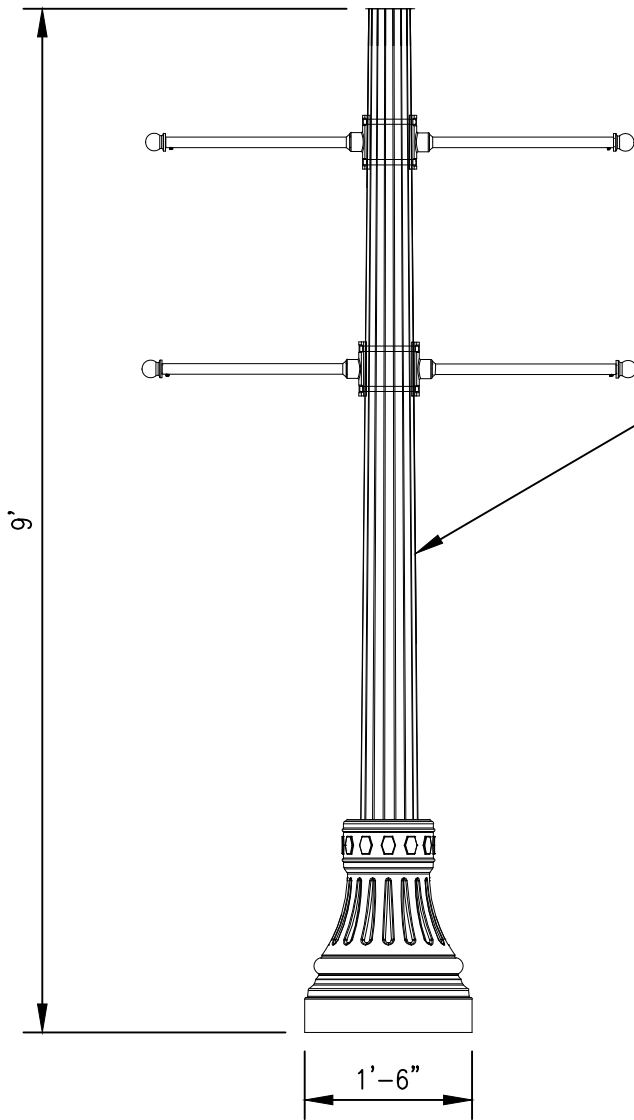
- H. Retrofit Two Piece Base Cover
  - 1. Manufacturers:
    - a) Required: WJ Whatley
    - b) Preferred: None
    - c) Disallowed: All Others
  - 2. Component Characteristics:
    - a) Model number: D9M/CC-2
    - b) GFI receptacle 10" above plate
    - c) Low profile expandable in-use cover

### 4. INSTALLATION REQUIREMENTS

### 5. EVALUATION or COMMISSIONING

### 6. EXHIBITS

- A. 9 FT Pole

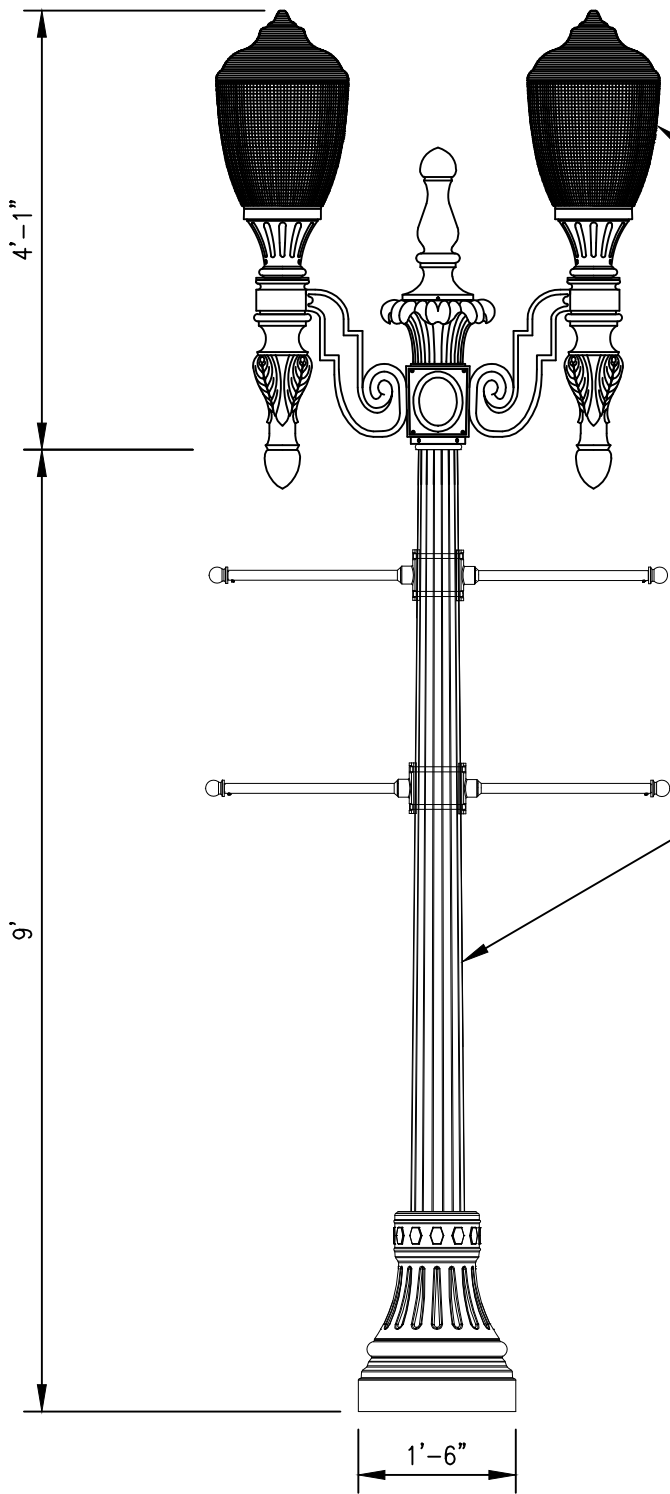


WJ WHATLEY  
#WDN2476-9(2)

USC CAMPUS STANDARD ASSEMBLY  
9FT POLE  
Contact:  
Prudential Lighting Products  
Crissy Cosci  
1737 E 21st Street  
Los Angeles, CA 90058  
213-477-1643  
01/10/2013

## USC BASIS OF DESIGN

B. 9 Ft Pole – Twin Arms



HANOVER  
#L-7842-F

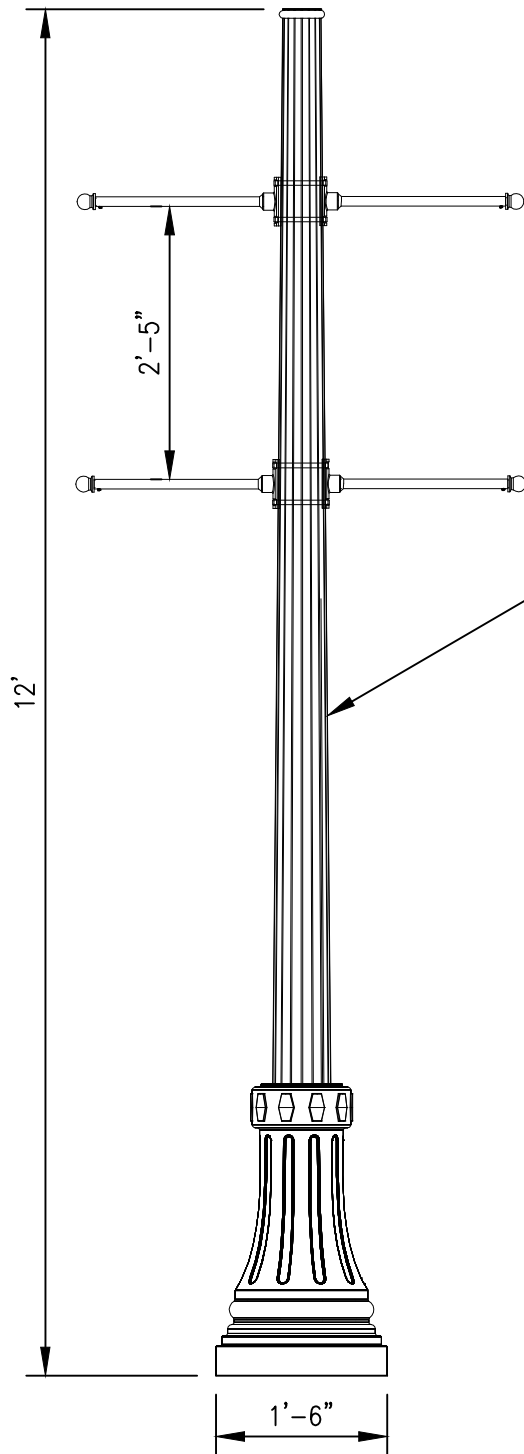
WJ WHATLEY  
#WDN2476-9(2)

USC CAMPUS STANDARD ASSEMBLY  
9FT POLE - TWIN ARMS  
Contact:  
Prudential Lighting Products  
Crissy Cosci  
1737 E 21st Street  
Los Angeles, CA 90058  
213-477-1643  
01/10/2013



## USC BASIS OF DESIGN

C. 12 FT Pole

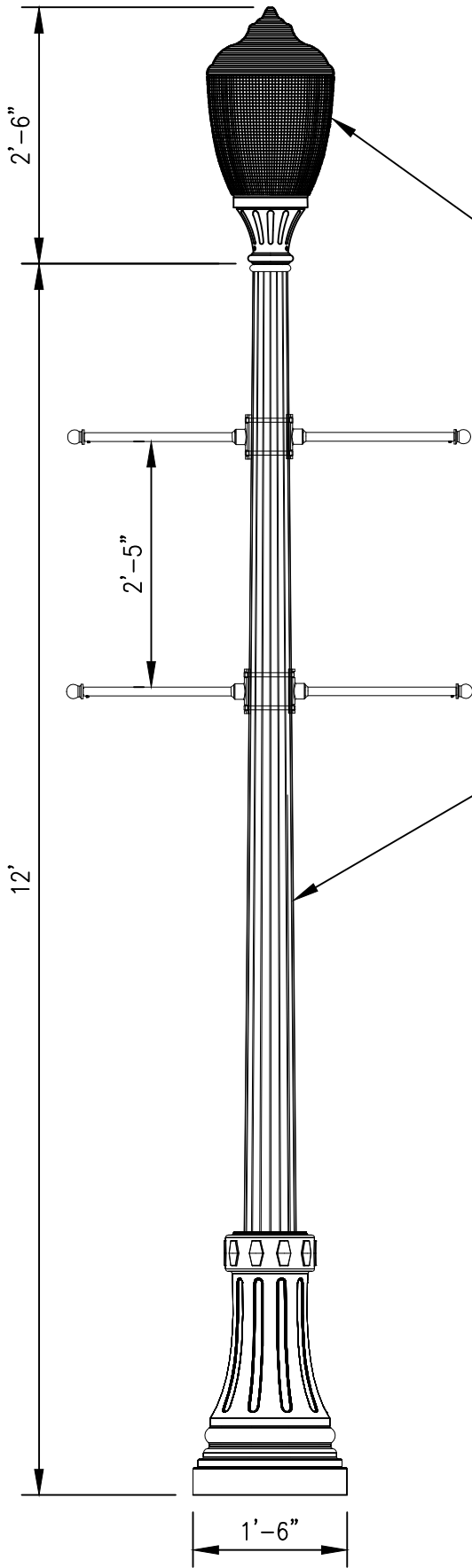


WJ WHATLEY  
#WDN2470-12

USC CAMPUS STANDARD ASSEMBLY  
12FT POLE  
Contact:  
Prudential Lighting Products  
Crissy Cosci  
1737 E 21st Street  
Los Angeles, CA 90058  
213-477-1643  
01/10/2013

## USC BASIS OF DESIGN

D. 12 FT Pole with HID Head



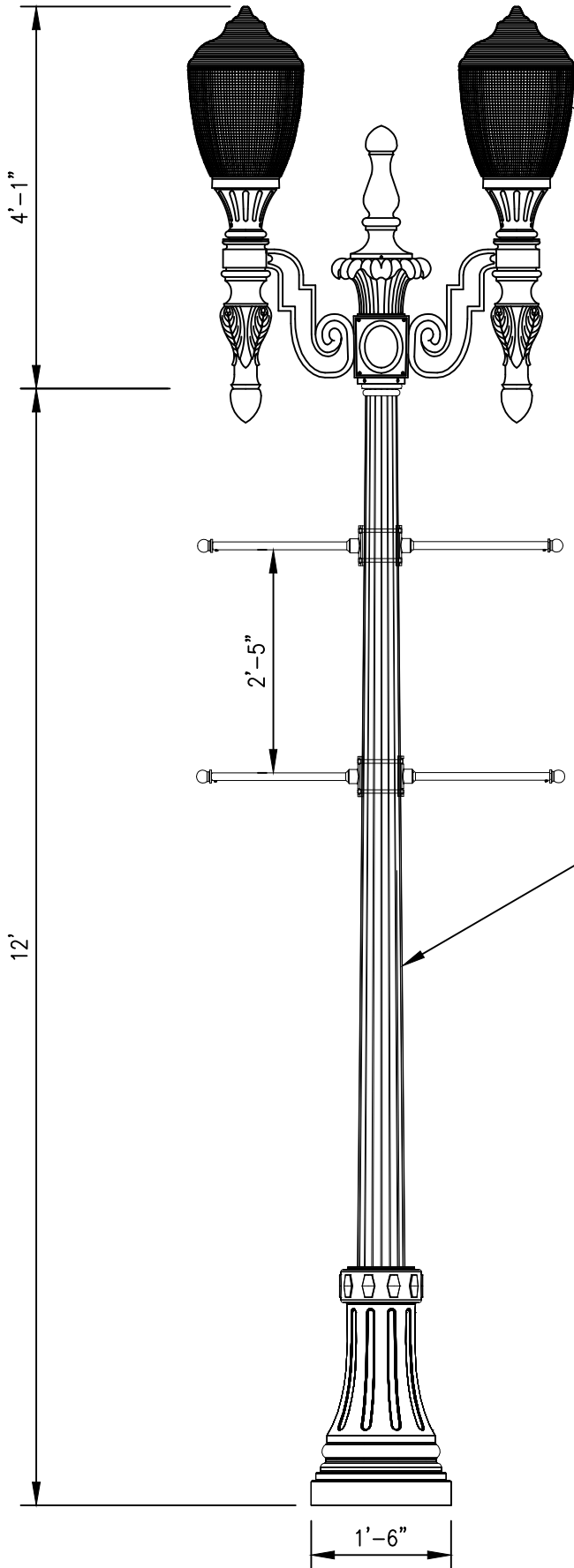
HADCO  
#L-7842-F

WJ WHATLEY  
#WDN2470-12

USC CAMPUS STANDARD ASSEMBLY  
12FT POLE & LUMINAIRE  
Contact:  
Prudential Lighting Products  
Crissy Cosci  
1737 E 21st Street  
Los Angeles, CA 90058  
213-477-1643  
01/10/2013

## USC BASIS OF DESIGN

E. 12 FT Pole – Twin Arms



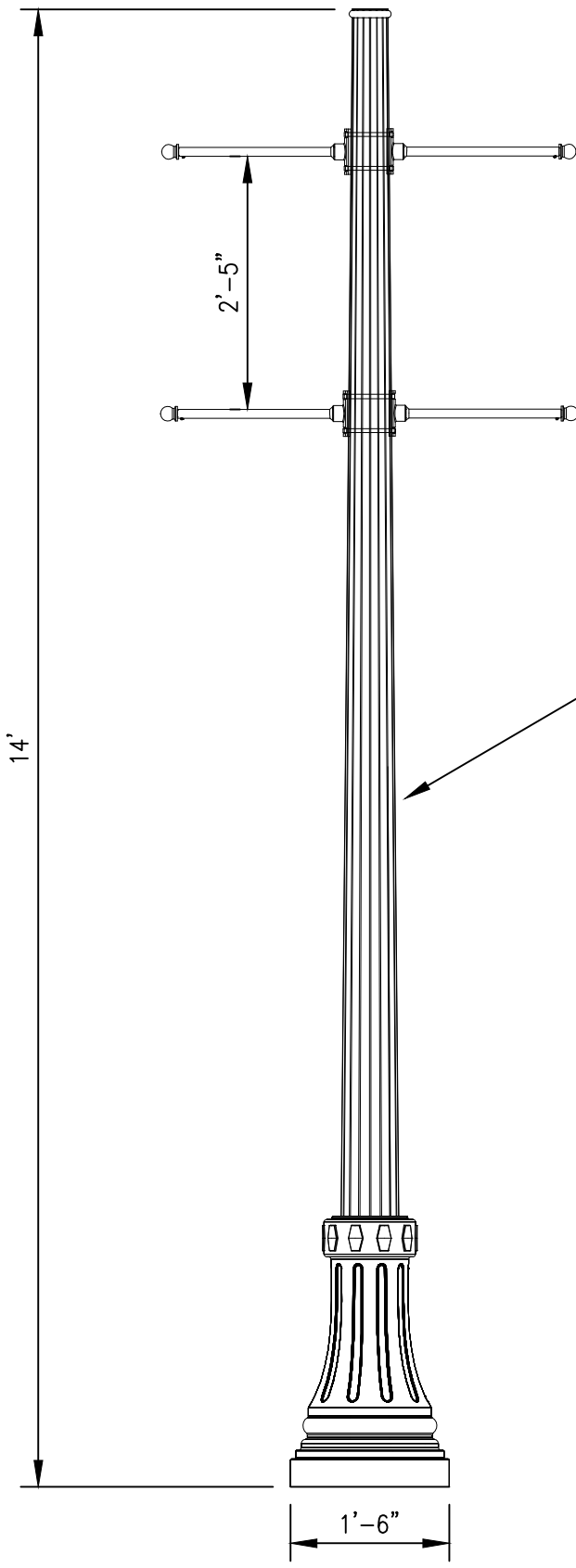
HADCO  
#L-7842-F

WJ WHATLEY  
#WDN2470-12

USC CAMPUS STANDARD ASSEMBLY  
12FT POLE - TWIN ARMS  
Contact:  
Prudential Lighting Products  
Crissy Cosci  
1737 E 21st Street  
Los Angeles, CA 90058  
213-477-1643  
01/10/2013

## USC BASIS OF DESIGN

F. 14 FT Pole



WJ WHATLEY  
#WDN2470-14

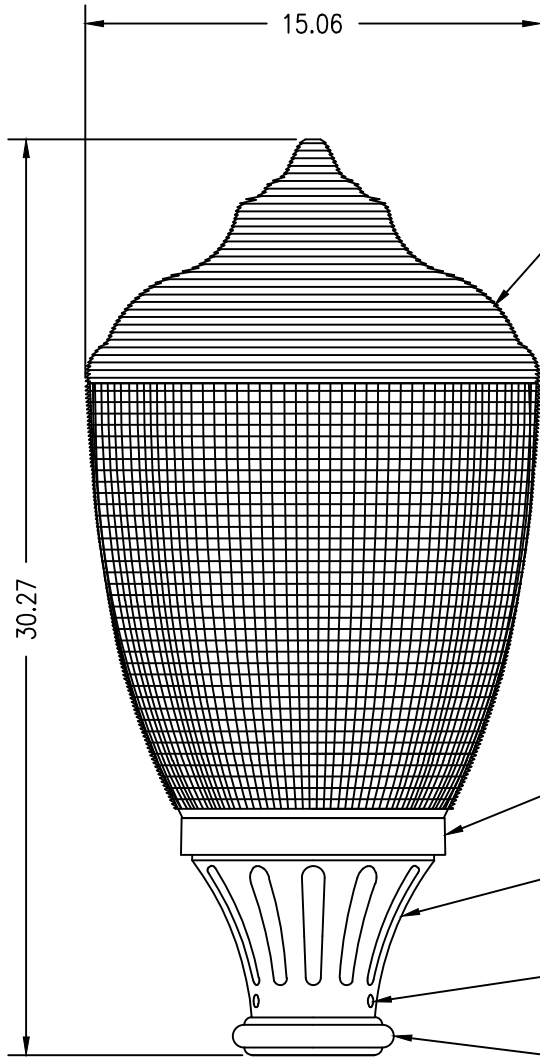
USC CAMPUS STANDARD ASSEMBLY  
14FT POLE  
Contact:  
Prudential Lighting Products  
Crissy Cosci  
1737 E 21st Street  
Los Angeles, CA 90058  
213-477-1643  
01/10/2013



## USC BASIS OF DESIGN

G. HID Head

PART NUMBER L7842F-BRZ



Color:  
Hanover BRZ

GLOBE: CLEAR  
PRISMATIC ACRYLIC,  
TYPE V OPTICS

REFLECTOR:  
HYDROFORMED  
ALUMINUM

SOCKET: PORCELAIN  
MOGUL BASE  
(lamp by others)

SOCKET BRACKET:  
GALVANIZED STEEL  
2-PIECE ADJUSTABLE

BALLAST COVER:  
DIE-CAST ALUMINUM

BALLAST: FACTORY  
PRE-WIRED & TESTED  
150W HPS, 208V

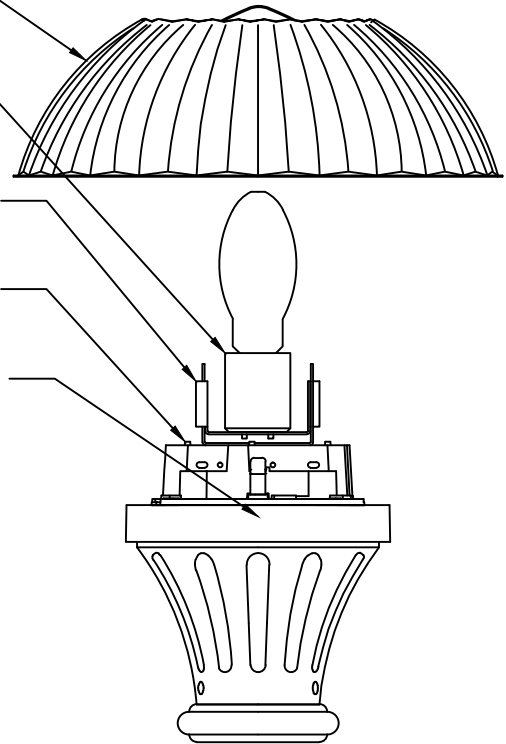
GLOBE HOLDER:  
CAST ALUMINUM

BALLAST HOUSING:  
CAST ALUMINUM  
W/ ACCESS DOOR

FASTENER:  
STAINLESS STEEL  
ALLEN HEAD SET SCREW

SLIP FITTER:  
3" O.D.

Lamping &  
Reflector  
Detail



Contact:  
Prudential Lighting Products  
1737 E 21st Street  
Los Angeles, CA 90058  
213-477-1643

BUG Rating B4-U3-G3

# Full Specification Fixture Drawing

NOTICE:  
THIS DRAWING IS FOR REFERENCE  
ONLY. CHECK FOR LATEST REVISION  
PRIOR TO ORDERING

**PHILIPS  
HADCO**

100 Craftway Drive  
Littlestown, Pa 17340  
Phone 800-331-4185  
Fax 717-359-9289  
www.hanoverlantern.com

JOB NAME:  
*University of Southern California*

REP. TERRITORY:  
*L17*

**CONFIDENTIAL:**  
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PRODUCT APPROVALS

HANOVER  
LANTERN      *JAZ*

CUST.

SCALE:

*1:6*

DATE:

*04/26/11*

DRAWN BY:

*CMG*

DRAWING NUMBER:

*L7842-DWG01*

REP:

*Prudential Lighting*

REV:

*E*

PCN: *12-048*

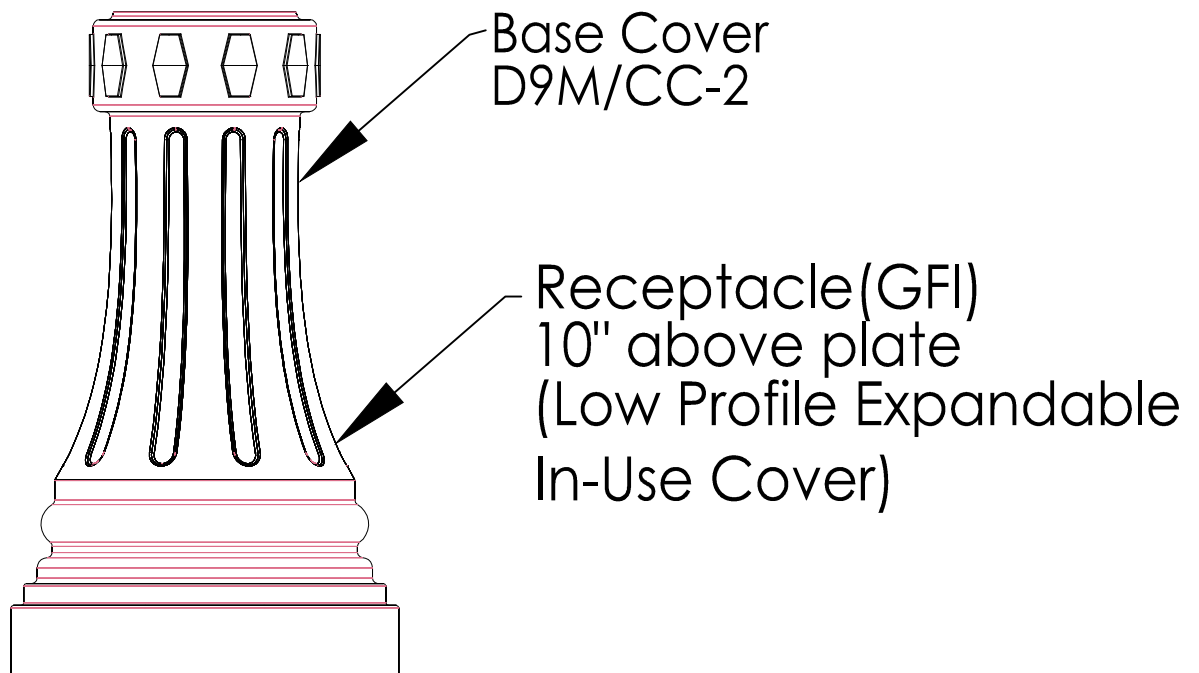
BY:

*CMG*

DATE: *05/30/12*

## **USC BASIS OF DESIGN**

H. Retrofit Two Piece Base Cover



**USC CAMPUS STANDARD ASSEMBLY  
RETROPIT TWO PIECE BASE COVER**

Contact:

Prudential Lighting Products

Crissy Cosci

1737 E 21st Street

Los Angeles, CA 90058

213-477-1643

01/10/2013

**USC BASIS OF DESIGN**

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 27 0000 COMMUNICATIONS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document for the implementation of communications infrastructure to support voice, data and audiovisual services for all facilities.
1. For other related requirements, refer to Section 27 0543 “Underground Ducts and Raceways,” 27 1000 “Structured Cabling System,” 03 7000 “Concrete,” “Information Technology Services (ITS) Base Building and Remodeling”, “Underground Telecommunications Service” and “USC-ITS Structured Cabling for Commercial Building Specification”.
  2. This document specifically addresses IT and Telecommunication Spaces. Below is a list of the spaces and acronyms used in this document and industry wide.
    - a) MDF – Main Distribution Frame, Primary Interconnection Room
    - b) IDF – Intermediate Distribution Frame, Secondary Interconnection Rooms
    - c) TR – Telecommunications Room – same as IDF
    - d) MPOE – Main Point of Entry
    - e) EF – Entrance Facility
    - f) ER – Equipment Room
    - g) DC – Distribution Corners – Campus Distribution Centers
    - h) Server Room – Room for Client Servers and other IT Equipment
    - i) Data Center – Campus Data Center
- B. The following table summarizes the types of particular requirements identified within this section:

<b>Requirements listed</b>	<b>Preferences Listed</b>	<b>Disallowed items listed</b>	<b>Item requiring commissioning/testing</b>
Telecom Spaces, Grounding,	Room Sizes, Paint, Floor Tile	None	None

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
1. Required:
    - a) Engagement of a qualified Telecommunication Design and Consulting Engineer to provide design specifications and drawings in accordance with USC standards and specifications.
    - b) Dedicated Telecommunication Spaces are required to meet the size and functionality of the building. Larger facilities will require a dedicated Entrance Facility (EF) to land outside plant cable and service provider equipment from voice, data and CATV providers. This room is to be within 50’ of the building envelope.
    - c) Four (4) 4” conduits for high-capacity buildings require redundant feeds from two nearest Telecommunication Vaults and Three (3) 4” for low-capacity buildings.
    - d) Telecommunication Rooms (TR) or Intermediate Distribution Frames (IDF)

## USC DESIGN GUIDELINES

- shall be required to meet structured cabling standard distance limitations or 90 meters. TRs shall be centrally located and sized at a minimum of 100 SF for each 20,000 SF, and 50 SF for each additional 10,000 SF of space served.
- e) Telecom spaces can be located to serve multiple floors, thereby reducing mechanical, electrical, network and other costs, but must be sized appropriately to meet the multiple floor requirements.
  - f) Telecom spaces in multi-floor buildings should be aligned vertically to facilitate distribution between floors and simplify conduit runs.
  - g) A minimum of two walls shall be covered with  $\frac{3}{4}$ " AC plywood 8' high, rigidly installed and capable of supporting equipment. Plywood must be fire retardant and painted off white with fire retardant paint with stamp exposed.
  - h) Telecom spaces shall be locked with a E-key or card access, if available.
  - i) Flooring is required in Server Rooms using anti-static floor tile or grounded floor tiles bonded to ground using manufacturer-recommended hardware. Grounding – Grounding is required in each telecommunications space in accordance with local codes and NEC 900-31 and ANSI/TIA/EIA 607. A #6 ground wire to building ground from the Ground Buss Bar.
  - j) Acceptable ground, if power service ground is not available an acceptable ground would include grounded water pipes, concrete encased ground, ring ground.
  - k) Emanating from Primary Bonding Busbar (PBB) for ER and EF or Secondary Bonding Busbar (SBB) for TR, all metal components shall have a continuous ground including each rack or cabinet and across all ladder rack connections.
  - l) Maintain a continuous and dedicated environmental control with thermostat (i.e. 24x7) for telecom spaces with active equipment. If emergency power is available, consider connecting it the HVAC system that serves telecom spaces with active equipment.
  - m) Direct access from a corridor is required, access through a secondary space is not acceptable.
  - n) A minimum of 4 dedicated 110V-20 Amp emergency power circuits for each TR is required on each equipment racks base on the level of the service on equipment racks.
  - o) Per code additional convenient 110V-15 Amp at 6 feet apart on each non egress walls in TR and ER rooms.
  - p) Each communication outlet shall require minimum of (1)  $1\frac{1}{4}$ " conduit from the box to stub out at least 6" above accessible ceiling or home run back to TR for Cat6A station cables.
  - q) Communication outlets for Cat6A- Zinc-coated or cadmium plated sheet steel 5S outlet boxes.
  - r) Extension rings will be fitted to accommodate duplex outlets (i.e. 2"x 4" Reduction ring) and set to come flush with finished surface of the wall.
2. Preferred:
- a) Open ceilings in the telecommunication spaces
  - b) Equipment Room, Main Telecommunications Rooms can be in the basement but not near water sources.
  - c) Humidity monitoring is desired for Server Rooms.

## USC DESIGN GUIDELINES

- d) Anti-static flooring is optional in MDF and IDF rooms.
  - e) To achieve infrastructure redundancy dual building entrances each coming from a separate vault with (2) 4" conduits from each location is desired.
  - f) Minimum of 4 dedicated emergency power circuits at each TR.
3. Disallowed:
- a) Sharing of Telecommunication spaces with janitorial, storage, mechanical, electrical or other spaces.
  - b) Overhead waste or water pipes, except for sprinkler as required by code.
- B. Quality Assurance requirements beyond standard 1 year warranty:
- 1. No Warranty Requirements.

### 3. PRODUCT REQUIREMENTS

- A. Not Used

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Plywood to be installed 6" to 12" above the floor to its height of 8' with no separation between sheets.
  - 2. If plywood installed over drywall with metal studs, use ¼" toggle bolts installed every 24".
  - 3. GBB to be installed 18" to 24" above finished floor mounted horizontally.
- B. Preferred:
  - 1. Direction 1: Paint should be off white in MDF and IDF
- C. Disallowed:
  - 1. Prohibition 1: No conduit runs are allowed to be installed on surface of the back board

### 5. EVALUATION or COMMISSIONING

- A. Not Used

**END OF DOCUMENT**



# USC DESIGN GUIDELINES

## 27 0543 UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATION SYSTEMS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
1. For other related requirements, refer to Section 27 0000 Communications, 27 1000 “Structured Cabling System,” 33 0000 “Order of Inverts,” 33 7000 “Electrical Utilities,” “Information Technology Services (ITS) Base Building and Remodeling” and “Underground Telecommunications Service”.
  2. This section covers the construction of Outside Plant (OSP) installation, pathways, vaults and conduit to provide telecommunication services to new buildings or ones being remodeled.
  3. Conduit and manhole crossing or designed on Public Property requires to apply for addendum to existing City of LA and USC franchise agreement for public right of way.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
Outside Plant, Underground Ducts, Manholes and Pull Boxes	Concrete Vaults, Conduits	Direct Bury Cable	Inspection

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
1. Required:
    - a) Project Manager in coordination with IT Services and Facilities Management Services will identify connection location(s) and designated manhole(s) or handhole(s) for each project.
    - b) IT Services and Facilities Management Services will provide details and fault current information for each Telecommunication utility vault and boxes.
    - c) Concrete encased duct banks for primary telecommunication cables
      - a) Spare ducts required in any concrete encased duct bank to allow for spare capacity beyond planned cable.
      - b) Three or four-4” conduits based on the building capacity is a minimum requirement
      - c) At least one of the 4” conduit shall contain (4) 1” innerducts
    - d) Direct buried ducts for dedicated telecommunication circuits shall have at least 12” separation from any electrical or other services.
    - e) Concrete reinforced utility vaults are required to meet routing needs, to control pulling tensions and to allow room for cable splicing.
    - f) Duct lengths to 400’ or less, unless calculations justify a longer run.

## USC DESIGN GUIDELINES

- g) Maximum bend amounts of no more than 180 degrees or no more than two 90-degree bends.
  - 2. Preferred:
    - a) Pre-cast polymer pull boxes will be considered where space limits the installation of a utility vault.
    - b) Utility vault and pull boxes shall be accessible from a minimum of three sides.
    - c) To achieve infrastructure redundancy dual building entrances each coming from a separate vault with (2) 4" conduits from each location is desired.
  - 3. Disallowed:
    - a) Direct bury cable
- B. Quality Assurance requirements beyond standard 1 year warranty:
- 1. No Warranty Requirements.
  - 2. Installed to industry standards and civil requirements

### 3. PRODUCT REQUIREMENTS

- A. Manufacturer – Underground ducts
- 1. Manufacturer:
    - a) Required: No requirements
    - b) Preferred: Jensen Precast
    - c) Disallowed: None
  - 2. Components Characteristics: - Underground ducts
    - a) Required: PVC Conduit
      - a) Type DB 40 4" diameter minimum. Fittings shall be DB solvent type from same manufacturer.
    - b) Required: PVC Conduit for direct burial
      - a) Schedule 40, UL Labeled for 90 degree C Cables. Fittings shall be Schedule 40, solvent type, from same manufacturer.
    - c) Required: Sleeves
      - a) Sleeves shall be Schedule 40 PVC conduit, 6-inch diameter
    - d) Required: Marker Tape
      - a) Plastic, vinyl or mylar, 6-inch wide and orange in color for telecommunications and labeled to indicate cable type.
    - e) Preferred:
      - a) No preferences.
    - f) Disallowed:
      - a) Lesser grade conduit or fittings
- B. Component – Manholes and Pull Boxes
- 1. Manufacturers:
    - a) Required:
      - a) Manhole frame and cover shall be East Jordan Iron Works 1805C with lettering "USC Telecom."
      - b) Pull box covers engraved with "USC Telecom."
    - b) Preferred:
      - a) Jensen Precast
      - b) Associated Concrete Products, Inc.
      - c) Brooks Products, Inc.

## USC DESIGN GUIDELINES

- d) Concrete Conduit Co.
- e) Penn-Cast Products, inc.
- c) Disallowed:
  - a) None.
- 2. Component Characteristics:
  - a) Required:
    - a) Provide precast telecommunication utility vault and boxes with 28-day, 3000 psi minimum compressive strength concrete and designed for AASHTO H-20 loading. Minimum dimensions for telecommunication utility vault and boxes are shown on the Drawings. Increase these dimensions as required by use of extension sections to accommodate the several raceway entrances at their required elevations.
    - b) Slope floors toward drain points, leaving no pockets or other nondraining areas. Provide drainage outlet or pump sump at the low point of the floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe. Where adjoining telecommunication utility vaults and boxes have common walls, provide a drain in only one telecommunication utility vault. In each common wall, install a 3-inch minimum drainpipe or scupper with the invert at floor elevation.
    - c) Provide a pulling iron embedded in the concrete wall opposite each raceway entrance and one in the floor vertically below the center of the telecommunication utility vaults and boxes cover. Utilize 3/4-inch round stock securely fastened to the overall steel reinforcement before concrete is poured.
    - d) Provide raceway entrances [as shown on the drawings] [on all four sides]. For raceways installed under this Contract, knockout panels or precast individual raceway openings may be used. On sides where no raceways are installed under this Contract, provide 12-inch high by 24-inch wide (minimum) knockout panels for future raceway installation.
    - e) Utilize heavy-duty type frames and covers made of cast iron, suitable for H-20 loading, and having machined bearing surfaces. Provide indented type covers, solid top design, with two drop handles each. On the upper side of each cover, cast or burned by welder, in integral letters no less than 2 inches high appropriate titles, ELECTRIC HIGH VOLTAGE (for above 600 volts), ELECTRIC LOW VOLTAGE (for 600 volts and below), USC TELECOM for all communication. Field stamp covers with telecommunication utility vaults and boxes numbers indicated on the Drawings.
    - f) Provide heavy-weight cable racks with adjustable arms and acceptable insulators for all cables in each manhole. Set adjustable inserts in the concrete walls for the attachment of racks. Do not use bolts or studs embedded in concrete for attaching racks. Set racks and inserts on not greater than 3-foot centers around the entire inside perimeter of the manhole, arranged so that all spare conduit ends are clear for future cable installation. Provide racks with a sufficient number of arms and insulators to accommodate cables for each conduit entering or leaving the utility vault , including spares.
    - g) Utilize telecommunication utility vault and boxes hardware of steel, hot-dip galvanized after fabrication.
    - h) Telecommunications utility vaults shall be 12'L X 6'W X 6.5'H or smaller as per number of conduits and cables splice points per ITS

## USC DESIGN GUIDELINES

- services approval.
- i) Each long wall shall contain 7 full height vertical concrete inserts and 2 in each short wall.
- j) Ladder Inserts shall be Unistrut type channel or Aikenstrut nonmetallic channel. Copper Ground Bus Bar on each long wall
- k) Pull boxes shall be precast polymer concrete or polymer foam
- l) Shall be one size larger than planned cable bend radii
- b) Preferred:
  - a) No preferences.
- c) Disallowed:
  - a) None.

### 4. INSTALLATION REQUIREMENTS

#### A. General

1. Required:
  - a) Coordinate installation of underground raceways with other outside and building construction work. Maintain existing outside utilities in operation.
  - b) Remove entirely and properly reinstall all raceway installations not in compliance with these requirements.
  - c) Provide a minimum cover of 2 feet over low voltage (telephone and data fiber and copper cabling underground raceways unless otherwise indicated.
  - d) Do not backfill underground direct burial and concrete-encased raceways until they have been inspected by the Engineer, Owner or their representative.
  - e) Warning Tapes: Bury warning tapes approximately 18 inches above all underground conduit runs or duct banks. Align parallel to and within 12 inches of the centerline of runs.
2. Separation and Support
  - a) Separate parallel runs of two or more raceways in a single trench with preformed, nonmetallic spacers designed for the purpose. Install spacers at intervals not greater than that specified in the NEC for support of the type of raceways used, and in no case greater than 10 feet.
  - b) Support raceways installed in fill areas to prevent accidental bending until backfilling is complete. Tie raceways to supports, and raceways and supports to the ground, so that raceways will not be displaced when concrete encasement or earth backfill is placed.
3. Arrangement and Routing
  - a) Arrange multiple conduit runs substantially in accordance with any details shown on the Drawings. Locate underground conduits where indicated on the Drawings and graded to the elevations shown.
  - b) Make minor changes in location or cross-section as necessary to avoid obstructions or conflicts. Where raceway runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, refer the condition to the Engineer for instructions before further work is done.
  - c) Slope duct banks downward, toward manholes, away from buildings, a minimum of 4"-6" per 100'.
  - d) Minimum 15'-20" bend radii for direction change
  - e) Where other utility piping systems are encountered, maintain a 12-inch minimum vertical separation between raceways and other systems at crossings. Maintain a 12-inch minimum separation between raceways over

## USC DESIGN GUIDELINES

- couplings in other piping systems. Refer conflicts with these requirements to the Engineer for instructions before further work is done.
- f) In multiple conduit runs, stagger raceway coupling locations so that couplings in adjacent raceways are not in the same transverse line.
4. Direct Earth Burial Conduit Zone Backfill Installation
- a) Backfill material for the conduit zone of direct burial conduit trenches may be selected from the excavated material if it is free from roots, foreign material, and oversized particles. Use material with 3/4-inch maximum particle size and suitable gradation for satisfactory compaction. Remove material if necessary to meet these requirements.
  - b) Imported 3/4-inch minus gravel or sand may be used in lieu of material from the excavation.
  - c) After conduits have been properly installed, backfill the trench with specified material placed around the conduits and carefully tamped around and over them with hand tampers.
5. Concrete Encasement
- a) Encase underground conduits in slurry as indicated below:
    - 1) Low Voltage – Telecommunications and Data (48V and below): Use 1 sack mix slurry. Maintain a minimum 3 inch envelope around all conduits in landscape areas.
    - 2) 1) Low Voltage – Telecommunications and Data (48V and below): Use 5 sack mix slurry. Maintain a minimum 3 inch envelope around all conduits in walkway, driveway and streets.
  - b) Maintain a grade of at least 4 inches per 100 feet, either from one telecommunication utility vault and boxes to the next, or from a high point between them, depending on the surface contour.
  - c) Hold conduits for concrete-encased raceways securely in place by acceptable window type spacer supports. Where, in the opinion of the Engineer, ground conditions are such as to require concrete forms, install forms constructed of materials and in a manner acceptable to the Engineer. No variations greater than 1/2 inch in 50 feet will be permitted from a straight line.
  - d) Envelopes may be poured directly against the sides of trenches if the cut is clean, even, and free of loose material. Remove loose material from trenches before and during pouring of concrete to ensure sound envelopes. Carefully spade slurry during pouring to eliminate all voids under and between raceways and honeycombing of the exterior surface.
  - e) Do not use power-driven tampers or agitators unless they are specifically designed for the application, in order to ensure that the watertight integrity of the raceways is maintained.
  - f) Generally, pour an entire slurry envelope in one continuous pour. Where more than one pour is necessary, terminate each pour in a sloped plane, and insert 3/4-inch reinforcing rod dowels extending into the slurry 18 inches minimum on each side of the joint. Obtain Engineer's approval for the number and location of dowels.
6. Telecommunication Utility Vault and Boxes
- a) Install manholes and handholes where shown on the drawings. Provide excavation, shoring, bracing, backfilling, grading, etc., in accordance with requirements specified elsewhere in these contract documents.
  - b) Utility boxes for telecommunications to be located in landscape areas.

## USC DESIGN GUIDELINES

- c) Do not install telecommunication utility vaults and boxes until final conduit grading, including field changes necessitated by underground interferences, has been determined. Set frames to final grades as required.
  - d) Make installation so that raceways enter manholes or handholes at nearly right angles and as near as possible to one end of a wall, unless otherwise indicated.
  - e) Install one ground rod in each telecommunication utility vaults and boxes. Connect all noncurrent-carrying metal parts in the telecommunication utility vault and any metallic raceway grounding bushings to this ground rod with No. 4/0 bare copper ground conductor and approved ground clamp and as required per NEC.
7. Preparation for Pulling in Conductors
- a) Do not install crushed or deformed raceways. Avoid traps in raceways where possible. Take care to prevent the lodging of concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.
  - b) Immediately after installation, plug or cap all raceway ends with water-tight and dust-tight seals until the time for pulling in conductors.
  - c) For concrete-encased raceways, after the concrete envelope has set, pull a mandrel of a diameter approximately 1/4 inch less than the raceway inside diameter, through each raceway. Then pull a bristle brush through each raceway to remove debris.
8. Empty Raceways
- a) Certain raceways will have no cabling pulled in as part of the Contract. Identify with tags at each end and at any intermediate pull point the origin and destination of each such empty raceway. Where a raceway has been identified with a name (number) in the Raceway Schedule, use that name on the tag in lieu of origin and destination. Provide a removable permanent cap over each end of each empty raceway. Provide a 3/8" nylon pull cord in each empty raceway.
9. As Built Conduit Drawings
- a) At the completion of Contract, provide as-built conduit Drawings showing location and depth of all conduits. Measure conduit locations from permanently fixed readily discernable landmarks such as building corners, columns, manhole centerline, etc.
- B. Preferred:
- 1. Pull boxes to be located in landscape areas
  - 2. Pull boxes shall be size larger than required to loop the cable in and out of the pull box without exceeding the minimum bend radii of the cable being installed.
  - 3. Ducts should enter manholes on the short side
- C. Disallowed:
- 1. Use of substandard material
  - 2. Failure to adhere to all applicable standards including NEC, BICSI, AT&T, and G.O. 128.

## USC DESIGN GUIDELINES

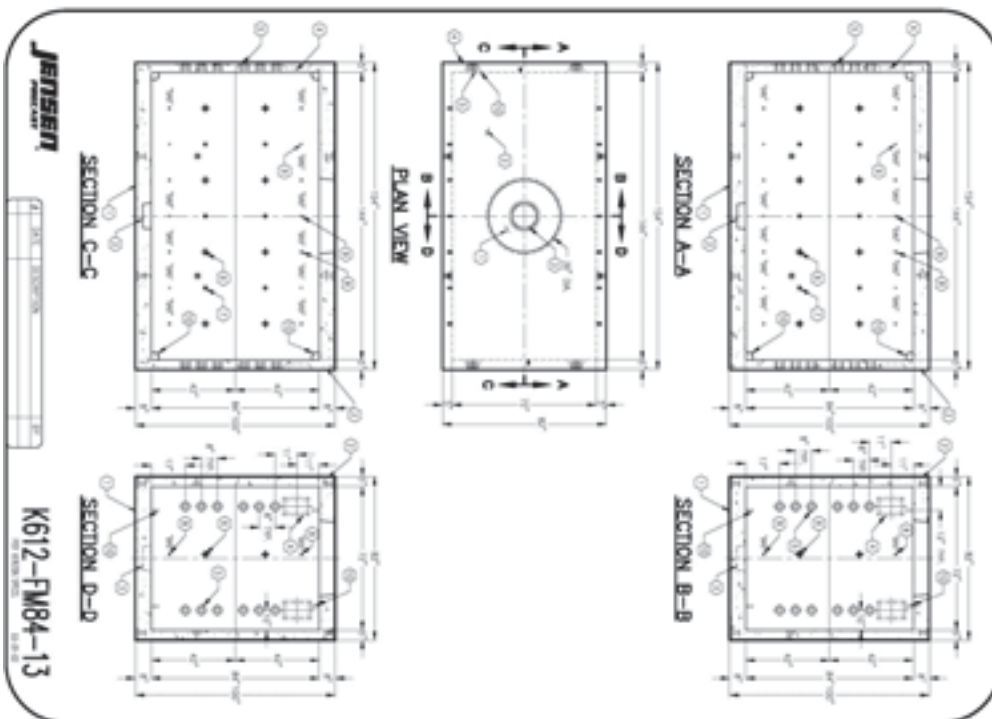
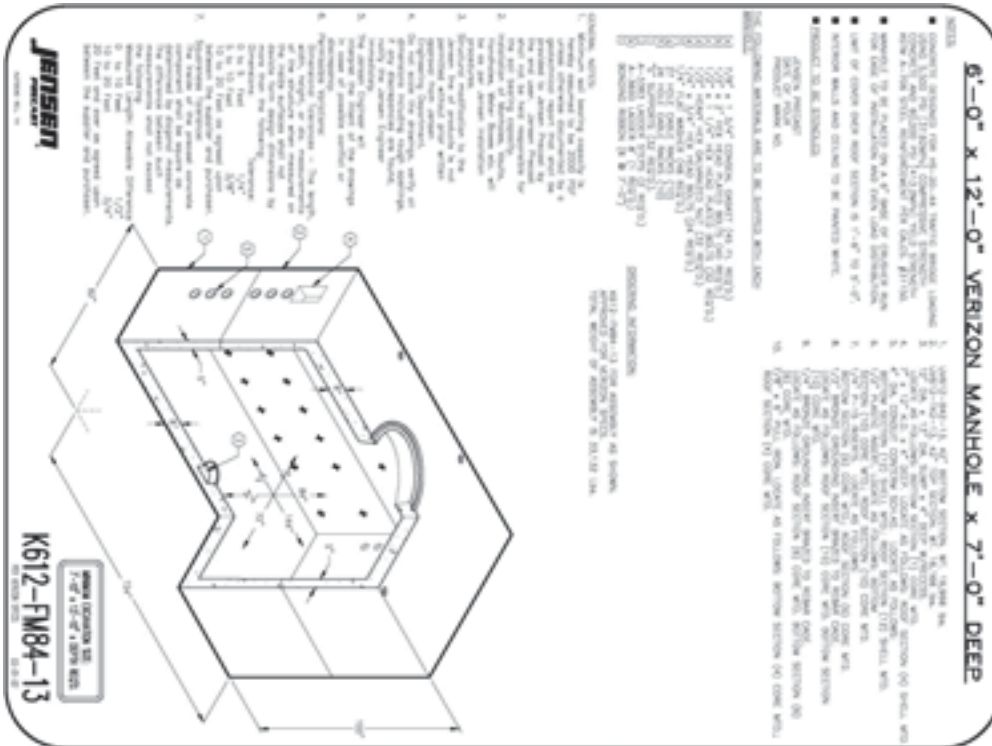
### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:
  - 1. Required: Contact USC Project Manager to arrange inspection by ITS department prior to pouring concrete and backfilling excavations.
  
- B. Documentation required:
  - 1. Test reports: Concrete
  - 2. Commissioning report: Per Civil requirements
  - 3. In-person witnessing: Prior to concrete pouring and excavation backfill
  
- C. Required testing protocols:
  - 1. None

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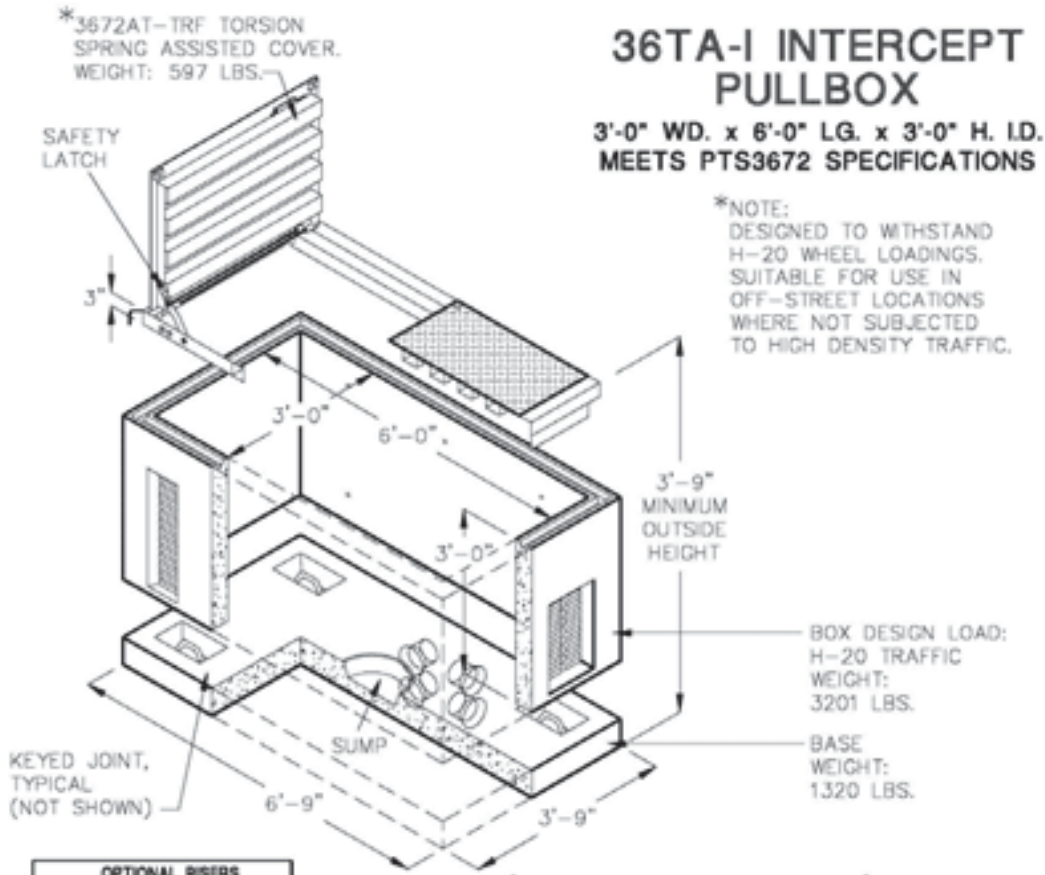
# USC DESIGN GUIDELINES

## APPENDIX





# USC DESIGN GUIDELINES

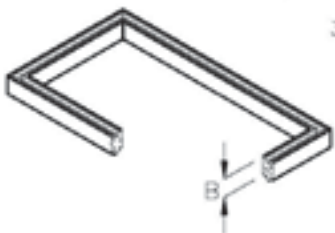


## 36TA-I INTERCEPT PULLBOX

**3'-0" WD. x 6'-0" LG. x 3'-0" H. I.D.  
MEETS PTS3672 SPECIFICATIONS**

**\*NOTE:**  
DESIGNED TO WITHSTAND H-20 WHEEL LOADINGS. SUITABLE FOR USE IN OFF-STREET LOCATIONS WHERE NOT SUBJECTED TO HIGH DENSITY TRAFFIC.

OPTIONAL RISERS (EXTENSIONS)		
MODEL NO.	R	WEIGHT
36-R6	6"	526 LBS.
36-R12	12"	1050 LBS.



**ADJUSTABLE TORSION SPRING ASSISTED COVERS (DIAMOND PLATE SURFACE)**  
**\*3672AT-TRF, 597 LBS. (H-20 TRAFFIC)**  
**OR**  
**3672AT-PKY, 490 LBS. (NON TRAFFIC)**



**ADJUSTABLE TORSION SPRING ASSISTED COVERS (NON-SLIP SURFACE)**  
**\*3672AT-TRF-AG, 588 LBS. (H-20 TRAFFIC)**  
**OR**  
**3672AT-PKY-AG, 481 LBS. (NON TRAFFIC)**

FOR COMPLETE DESIGN AND PRODUCT INFORMATION, CONTACT JENSEN PRECAST.

3/78/03  
P0361A.L.dwg  
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# USC DESIGN GUIDELINES

## 27 1000 STRUCTURED CABLING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
1. For other related requirements, refer to Section 27 0000 Communications, 27 0543 “Underground Ducts and Raceways,” 03 7000 “Concrete,” “Information Technology Services (ITS) Base Building and Remodeling”, “Underground Telecommunications Service” and “USC-ITS Structure cabling for Commercial Building Specification”.
  2. Structured Cabling incorporates voice, data, CATV and outside plant cable to support communications within a facility.
- B. The following table summarizes the types of particular requirements identified within this section:

<b>Requirements listed</b>	<b>Preferences Listed</b>	<b>Disallowed items listed</b>	<b>Item requiring commissioning/testing</b>
Horizontal, Backbone and Outside Plant Cabling, Equipment and Fittings, and Pathways	Cable types, Installation Standard, and Equipment Preferences	Non-approved manufacturers and equipment types	Cabling

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
1. Required:
    - a) Cable Tray or Ladder Rack in the IDF is required. Two levels; upper – horizontal cabling, lower – rack distribution cabling.
    - b) Two-post equipment racks are to be installed in the IDF in the quantity required to meet the cabling requirements with minimum 8” vertical double-sided wire manager. Three feet of clearance is required in the front and rear and 30” on the side.
    - c) Racks or cabinets shall be floor mounted.
    - d) Any penetrations of fire rated walls shall be caulked with approved fire stopping or use and approved intumescent pillow penetration device for cable tray installations.
    - e) Install corridor cable tray with sufficient clearance from ducts, beams or other obstructions that will hinder access. See detail in the appendix for required clearances.
    - f) Pulling of backbone cable is to be consolidated to maximize use of pathways and conduit space.
    - g) Support systems are required in accordance with BICSI guidelines
    - h) The standard for new building installation and existing building renovation installation shall be CAT6A, UTP, CMP.
    - i) The standard for retrofit in existing buildings shall be CAT6A UTP, CMP and

## USC DESIGN GUIDELINES

- CAT6 UTP, CMP for partial new remodel. Contact project manager for details.
- j) Terminations in accordance with IDC methodology and T568B is required. ITS requires 22-24 AWG copper cable.
  - k) MPTL (Modular Plug Terminated Link) is now recognized in the approved ANSI/TIA-568.2-D as an option for connecting devices above ceiling spaces.
  - l) Each building is fed with a minimum of 200 pair Cat 3 Copper cable.
  - m) Each building is fed with a minimum of 24 strands of single mode fiber optic cable from the nearest telecommunications vault.
  - n) Interior backbone copper and fiber optic cables will be designed per network requirement or end user requests.
  - o) Coax cable may be provided by Campus Televideo or cable TV provider at the option of the occupant.
- 2. Preferred:
    - a) Overhead cable tray for horizontal distribution for main pathways
    - b) Cable tray capacity shall not exceed 40%
    - c) Cable tray in IDF's need to be attached to the wall as well as the ceiling
    - d) Waterfalls, corner protectors and other devices should be used to support and protect cable.
    - e) Cable management shall be used at all fiber and copper termination and connection locations in the telecom spaces.
    - f) Rack mounted fiber enclosures are preferred.
  - 3. Disallowed:
    - a) None.
- B. Quality Assurance requirements beyond standard 1 year warranty:
- 1. Fiber and copper cabling shall be installed by a manufacturer certified installer and provide a performance warranty for a minimum of 25 years. All fiber and copper cabling, connectors and installation shall be covered by the 25 year Warranty Term.

### 3. PRODUCT REQUIREMENTS

- A. Component Cable Tray, Ladder Rack and Equipment Rack
  - 1. Manufacturers:
    - a) Required:
      - a) Cable Tray/Ladder Rack shall be Chatsworth, B-Line, Cabofil, or WBT.
      - b) Equipment rack shall be Chatsworth or B-Line standard black two-post rack.
    - b) Preferred:
      - a) No preferences.
    - c) Disallowed:
      - a) None.
  - 2. Component Characteristics:
    - a) Not Used
- B. Component Fiber Optic Cable
  - 1. Manufacturers:
    - a) Required:
      - a) Corning LANscape
    - b) Preferred:

## USC DESIGN GUIDELINES

- a) No preferences.
  - c) Disallowed:
    - a) None.
  - 2. Component Characteristics:
    - a) Required:
      - a) Enhanced 50µm Multimode Fiber Riser and Backbone.
      - b) LANscape Single Mode Fiber for intrabuilding backbone and riser.
      - c) LANscape Multimode 50µm Fiber for in-building riser if require.
    - b) Preferred:
      - a) SC or LC connectors on multi mode and Single mode cables.
      - b) UPC SC or LC ultra pre factorized connectors on single mode cable.
    - c) Disallowed:
      - a) Field terminated SC single mode connectors.
- C. Component CATEGORY 6A Cable
- 1. Manufacturers:
    - a) Required:
      - a) BerkTeck/Leviton or other approved manufacture CAT6 and CAT6A solutions.
      - b) Leviton CAT6 110 style wall mounted on existing and patch panel system for all new telecom rooms/new building.
      - c) RJ-45 IDC style connectors on the user end
    - b) Preferred:
      - a) 8" to 10" Wire Manager with cover
    - c) Disallowed:
      - a) None.
  - 2. Component Characteristics:
    - a) Required:
      - a) Horizontal Cable – Blue or Gray
      - b) Project provides patch cords
      - c) Station Patch Cords - Blue
      - d) Patch cord color requirements in the Equipment Room or IDF solid conductor Cat-6A
        - Data – Green
        - Station Cable – Blue
        - VoIP/Zoom voice – Yellow
        - Wireless – White
      - e) Faceplate – to match interior finish
      - f) Jack - Black.
    - b) Preferred:
      - a) No preferences.
    - c) Disallowed:
      - a) None.

## 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Install in accordance with BICSI and ANSI/TIA/EIA guidelines
  - 2. Installation by manufacturer certified technician
  - 3. Contractor must be certified by BerkTeck/Leviton or other approved manufacture CAT 6 and CAT6A solutions for all new installations.

## USC DESIGN GUIDELINES

4. USC labeling and numbering requirements.
    - a) Labels provided by USC
  5. As-built Drawing upon project completion in specified electronic format.
- B. Preferred:
1. By a USC approved Structure Cabling Contractor under USC ITS supervision.
- C. Disallowed:
1. Noncertified or electrical contractors
  2. Use of not USC approved equipment

### 5. EVALUATION or COMMISSIONING

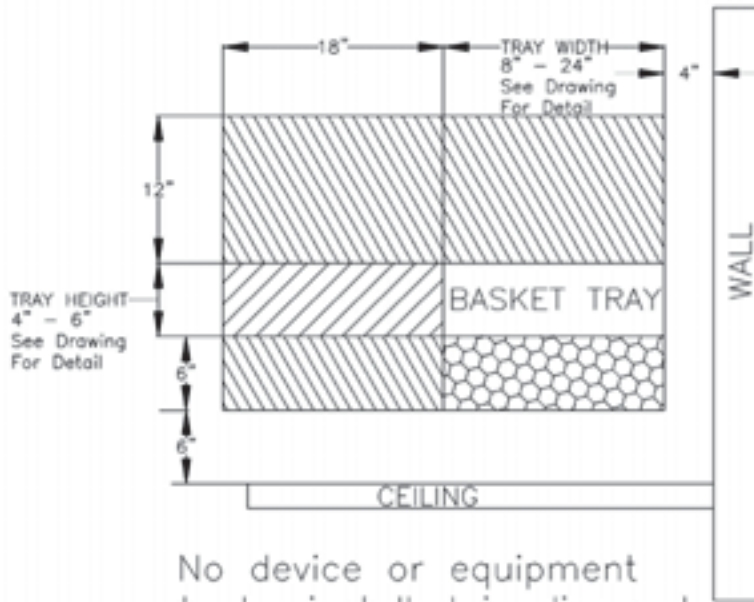
- A. List of items or systems requiring testing, evaluation, verification, or commissioning:
1. Required: Copper cabling Field testing with Fluke or equivalent test instrument to 568-B.1 transmission characteristics.
  2. Complete Link test and Channel Test
  3. Required: - Fiber testing for all multi-mode cabling to 526-14A, Method B, One Jumper Reference. Test for Length, Polarity, Attenuation
  4. Required: - Outside Plant Single mode fiber shall comply with OTDR testing.
    - a) Bi-Directional Testing for OSP
    - b) Power Meter for Riser Single mode fiber
- B. Documentation required:
1. Test reports: Copper and Fiber Test Report
  2. Commissioning report: None
  3. In-person witnessing: Optional
  4. Factory test results: If applicable
  5. Onsite test results: None
  6. South Coast Air Quality Management certificate: None
  7. UL/ETL/ArcFlash labeling: Electronic labeling of all cables in accordance with USC standards
  8. EnergyStar labeling: None
  9. Lead-free fixtures: :None
- C. Required testing protocols:
1. Copper Cabling –Category 6 & 6A field testing requirements per ANSI/TIA-568-C.2.
  2. Fiber Optic Cabling – ANSI/TIA/EIA 526-7 (Single mode) & 526-14A (Multimode), Method B, One Jumper Reference.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## APPENDIX

### Basket Tray Clearance Requirements



No device or equipment to be installed in diagonal shaded area.

No electrical or heat producing device to be installed in honeycomb shaded area.

At locations where separation can not be met, grounded shielding shall be used; each instance shall require the written approval of the Project Manager and USC ITS Department.

# USC DESIGN GUIDELINES

## 27 4100 AUDIO-VIDEO SYSTEMS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document for the implementation of audiovisual systems at USC and specifically in rooms supported by ITS-LE (Information Technology Services – Learning Environments). General education use rooms are essential components in the University of Southern California’s (USC) instructional mission. Technology enhanced learning spaces have increasing complex design and technical requirements. This section is intended to inform the University’s professional audiovisual design consultants and integrators of the University’s expectations and requirements for the implementation of audiovisual and multimedia technology specifically in general education spaces and in spaces where such design guidelines and direction is required.
- B. ITS-LE preferences and requirements are indicated in this document for the implementation of audiovisual systems at USC and specifically in rooms on the University Park Campus (UPC) and the Health Sciences Campus (HSC) supported by ITS-LE (Information Technology Services – Learning Environments). This document provides guidance for the AV systems design and building process to verify the adherence to the standards and benchmarks in spaces that have been defined as or may be supported by ITS-LE including; classrooms, conference rooms, auditoria and other related spaces.
- C. The ITS-LE service and support delivery model, MOMS (Multimedia Operations Management System) is the basis for the design requirements that follow. The MOMS is a remote based operations management, AV systems control, and meta-data aggregation platform.
- D. Background
  1. ITS-LE Technology Classroom Support Services is a department of ITS. ITS-LE is responsible for, and manages, the University of Southern California UPC and HSC campus general education use classrooms and other related spaces.
  2. The design guidelines for classrooms that follow were developed by ITS-LE and reviewed and endorsed by a variety of faculty committees including the Faculty Senate’s Council on University Facilities and the Strategic Technology Forum (STF).
  3. ITS-LE brings a broad knowledge of the AV systems and solutions deployed at the university within the context of the institutions enterprise and how systems are inter-related and function in conjunction with an intimate understanding of the constituent’s pedagogical needs and requirements.
  4. ITS-LE will assist consultants, designers and integrators to define AV solutions that best meet the needs of the university community, various departments and the specific project and constituent’s requirements.
  5. For any defined general use spaces, ITS-LE should be consulted and review consultant or vendor led proposed AV System designs.
  6. ITS-LE will provide infrastructure specifications and requirements for all AV systems defined as ITS-LE MOMS Support based environments.

## USC DESIGN GUIDELINES

- E. Programming Intentions: The following Design Goals have been established for USC’s general use rooms:
1. To provide the most effective learning environments based on desired pedagogy.
  2. To provide an environment designed to enhance a student’s ability to understand, observe and participate in active learning.
  3. To provide an environment that is comfortable for students and instructors as well as durable, reliable, and easy to maintain.
  4. To provide technology that is reliable and easy for faculty and student operators to use through standardization of controls, layouts, and equipment.
  5. ITS-LE managed spaces are generally institution-wide resources. The term “classroom” includes general-purpose classrooms, but also auditoria, seminar rooms, breakout rooms and other rooms used primarily for scheduled non-laboratory based instruction.
  6. Design standards for spaces depend on the size and shape of the room(s) in question, the intended capacity, the type of furniture desired, the teaching pedagogy required and the level of technological equipment and furniture incorporated into the room.
- F. The following table summarizes the types of particular requirements identified within this section:

<b>Requirements listed</b>	<b>Preferences Listed</b>	<b>Disallowed items listed</b>	<b>Item requiring commissioning/testing</b>
Audio, Video and Control system devices and equipment	Control Systems, Asset Management, Projectors, Projection Screens, Flat Panel Displays, Loudspeakers, Wireless Microphones, Mounts, Lecterns, Amplifiers,		Audio, Video and Control system devices and equipment

- G. ITS-LE has established the following basic Room Type configurations:
1. Seminar/Conferencing/Meeting Rooms - Seminar/Conferencing/Meeting Rooms: These spaces are often distinguished by their smaller size (5 to 20 occupants) with furniture that allows occupants to configure as needed such as to gather around a conference-type table arrangement for face-to-face discussions. Breakout rooms are generally smaller (5 to 10 occupants) while seminar rooms are generally larger (10 to 25 occupants). Seminar rooms are scheduled independently while Breakout rooms are generally scheduled in conjunction with other Breakout rooms and a primary classroom. Conference rooms may also be distinguished by the videoconferencing technologies integrated into the rooms.



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2. Collaborative Spaces - Collaboration Spaces also a subset of the general use classroom configuration, these spaces are distinguished by technology integrated into spaces not considered formal teaching spaces. These spaces are also referred to soft spaces or in-between spaces. Furniture layout can vary from single seats to small “pods”. Collaboration spaces can range in size from small (2-4 seats) to large (5-10 seats).
  3. Classroom – General standard - General Classrooms – Single display. These comprise the majority of instructional spaces at the UCS’s UPC campus. They can range in size from 18 up to 100 seats with a variety of seating, furniture types and furniture layouts. Smaller classrooms generally have loose “reconfigurable” furniture, flat floors and carpet; larger classrooms (more than 60 students) may have tiers/steps to elevate the students in the rear of the room to improve sightlines to the front of the room.
  4. Classroom – Multi-display. General Classrooms – Multi-display. These rooms are a subset of the general classroom configuration. These rooms generally have layouts that require multiple screens or displays to address sightlines, viewing angles and other such reasons. These rooms generally feature multiple displays or projection on multiple surface, reconfigurable seating, tables, etc. Multi-display rooms can range in size from small (20-25 seats) to large (over 60 seats) depending on pedagogical needs.
  5. Auditoria – Small, medium, and large. These spaces range from the smaller rooms (60 seats) to large lecture rooms (300+) that can accommodate hundreds of students in a traditional lecture format. Rooms are distinguished by the tiers/slope of the room and fixed seating furniture. Special requirements to support auditoria include projection rooms (either front or rear projection) and larger lobby/foyer spaces to accommodate egress and exiting of large numbers of students. These rooms also contain a full complement of audiovisual support technologies not found in in other room types.
- H. Related Work
1. For other related requirements, refer to Sections
    - a) 27 0000 Communications
    - b) 27 1000 Structured Cabling

## 2. PROCEDURAL REQUIREMENTS

- A. ITS-LE must be included in programming/feasibility study project meetings to help define classroom and technology requirements for ITS-LE supported spaces. Inclusion allows design teams to understand ITS-LE’s standards and expectations. ITS-LE should also be included in Schematic Design and Design Development meetings as the project progresses. At that time ITS-LE will supply project specific information to the design team.
- B. Questions to ask when starting a new project:
  1. Required:
    - a) Will this be an improvement project (TI) or will this be new construction?
    - b) Has it been determined if the location is to be an ITS-LE supported by the MOMS environment and, if not is it known who will support the technology?
    - c) Is there a tech support department or other defined team currently in place to support any existing technology?

## USC DESIGN GUIDELINES

- d) Has there been a pedagogical needs analysis to clearly define technology?
  - e) Will tech support be localized (in building), remote (on/off campus), or a hybrid?
  - f) Will AV hardware usage and control metadata be collected?
  - g) Will the proposed project be integrated into the existing ITS-LE support model at a future time? If so consider impact of using another non-ITS supported meta-control system (such as AMX or Crestron based).
- 2. Preferred:
    - a) Early involvement with design team and AV consultants and vendors..
  - 3. Disallowed:
    - a) None.
- C. AV Performance Standards:
- 1. Required:
    - a) No Requirements.
  - 2. Preferred:
    - a) AV Designers/consultants and integrators should be free to select the best solution that fits the specific control system scenario. If the space is intended to be ITS-LE MOMS supported, system designs should conform to the Extron control system defined by ITS-LE either directly by providing interface with Extron Global View Enterprise for enterprise metadata control and metadata collection.
    - b) AV systems design principles must be grounded in mathematical, scientific and physiological principles such as those defined by InfoComm, BICSI, ANSI and other recognized professional trade organizations. It is assumed that the designers/consultants/integrators have a working knowledge of the topics and most common principles related to educational spaces, learning environments and AV systems designs. CTS, CTS-D and CTS-I are preferred for all audiovisual system designers, consultants and integrators.
    - c) New audiovisual system designs should include a Digital signaling and transmission path as primary transmission and control with allowance for analogy pathways as needed. All digital systems must be HDCP compliant. High-Bandwidth Digital Content Protection is a copy protection scheme to eliminate the interception of digital data between the sources to the display in order to prevent copying of digital audio and video content as it travels across connections. USC requires all systems to be designed to work within the established regulation framework.
    - d) Because the overall project requirements depend on the physical environment in which systems will be installed, the overall design and integration process includes coordination with architects, interior designs, acoustics, lighting, structural, mechanical, data and electrical systems specialist, during the design, construction and implementation phases.
    - e) Designers/consultants/integrators should create systems that are intended to meet specific needs of the intended users, but which can also operate within the context of enterprise systems as required. Systems should consider current and future support needs.
    - f) ITS-LE will specify, review or otherwise confirm critical pathways and base building requirements early in the design process and will provide

## USC DESIGN GUIDELINES

- infrastructure design guidance for potential ITS-LE and MOMS supported AV systems in the program.
- g) Best practice to provide any required infrastructure to support a complete system, even if initial systems installation phase does not include the full program. This increases flexibility for future planning and provisioning.
  - h) Specialty systems designs should include baseline ITS-LE audio-visual designs to enable support services.
  - i) Provide line diagrams of audiovisual systems in Design Development drawings.
  - j) Provide construction drawings showing actual infrastructure locations, conduit sizes and details.
3. Disallowed:
- a) None.
- D. Data/Video Projection / Screen Standards:
- 1. Required:
    - a) None
  - 2. Preferred:
    - a) Screen Aspect Ratio and projection standard in all ITS-LE MOMS supported classrooms shall be the 16:10 format.
    - b) General classroom screens are 16:10, 60" x 96" wall or ceiling mounted (as architecturally appropriate), motorized, non-tab tensioned screens.
    - c) Bottom of viewable screen should fall no lower than 42" A.F.F.
    - d) Follow best practices in AV sightline studies to determine the most appropriate seating layout, screen selection for a clear field of view including the lowest visible point on the display surface, nearest viewer LoS (Line of Sight), farthest viewers LoS, off axis distortion and other ergonomic factors for a preferred field of vision and viewing comfort tolerance.
    - e) Actual screen/display location selection based on above factors in addition to end-user requirements.
    - f) Tile mounts or Pole mount as needed.
    - g) Provide security mounting hardware for projector.
    - h) Where larger screens are needed and can be accommodated in the space, the preferred size is 69" x 110" with same specifications as above.
    - i) Screens are generally centered on front wall or offset if room width allows. Room width and size will determine if screen is to be offset or angled.
    - j) All ITS-LE supported classrooms should be equipped with a minimum of one 60" x 96", 16:10 wall mounted projection screen. All projection screens should be flat matte white finish without borders. The ideal distance between the first row of seats and the screen is 2 times the screen width; the minimum distance between the seats and the screen is 1.5 times the screen width.
    - k) Projection screen(s) should be sized according to the formula that says the farthest viewer should be no more than 4.3 times the screen height from the screen:
      - a) Projected Images =  $VD / 4.3 = SH \times 1.333$
      - b) Where: SH = Screen Height
      - c) VD = Distance to last row of viewers

## USC DESIGN GUIDELINES

- l) Where appropriate projection screens should be sized to accommodate both widescreen aspect ratios and also accommodate legacy optical projection equipment (e.g., overhead projectors, 35mm slide projectors, etc.) Slides Screen Height Screen Width
    - a) Single Horizontal =  $VD / 7.1 = SH \times 1.4967$
    - b) Dual Horizontal =  $VD / 7.1 = (SH \times 1.4967)^2$
    - c) Single Vertical =  $(VD / 7.1) \times 1.4967 = VD / 7.1$
    - d) Dual Vertical =  $(VD / 7.1) \times 1.4967 = (VD / 7.1)^2$
    - e) Super Slides =  $(VD / 7.1) \times 1.4967 = SH$
    - f) Where: SH = Screen Height
    - g) VD = Distance to last row of viewers
  - m) The top of the projection screen should subtend at an angle no greater than 35 degrees from the horizontal to viewers in the front row.
  - n) Projection screens should be mounted far enough away from the wall to clear any chalkboards; map hooks, chalkboard lights, etc., and should extend to not less than 42" AFF when fully lowered.
  - o) The preferred solution is to have one wide projection screen in a room with a single data projector. No seams are allowed on the viewing portion of any projection screen.
  - p) However, two side-by-side screens are standard in auditoria when space will accommodate or when two data projectors are necessary to provide acceptable viewing angles for students. If dual screens are used, controls should be provided that will the instructor to lower/raise both screens simultaneously as well as lower/raise screens as individual screens.
  - q) Projection screens 6-feet wide or wider should be motorized. When motorized projection screens are used they must be installed with screen fabric centered on front wall and motor offset to one side. A manual switch to operate screen should be located on the side of the screen closest to the teaching podium at 48" AFF.
  - r) Projection screens should have variable "stop" controls that will allow the screen to be partially raised and/or lowered per instructor's need.
  - s) Motorized projection screens should also be controlled via the equipment control system touch panel on the podium in Level "C" and "E" rooms.
  - t) Where stationary projection screens are specified (e.g., studio broadcast classrooms) motorized moveable covers should be provided to protect the screen surface when not in use. Review Design and specification of screen and covers with CSS staff.
  - u) In designated rooms, walls may be used in place of manufactured projection screen. This includes projection paints, roll-on surfaces, etc.
  - v) Projection walls, unless otherwise indicated by ITS-LE staff, should be painted with IdeaPaint product Pro or Create commercial applications approved paint. Any other solutions shall be evaluated by ITS-LE
3. Disallowed:
- a) None.
- E. Transmission and Signaling Pathway Standards:
- 1. Required:
    - a) None

## USC DESIGN GUIDELINES

2. Preferred:
    - a) All AV system designs must be based on the current standards in digital signals and transmission.
    - b) Provide support for VGA input until 2015.
    - c) Provide support for Composite Video until 2015.
    - d) All new AV systems shall be digital and based on the HDMI (High-Definition Multimedia Interface) cable standards.
    - e) All new AV systems shall be HDCP compliant.
    - f) All display technologies must be EDID compliant when in a control system or digital signage environment.
  3. Disallowed:
    - a) None.
- F. Digital Signage – When Supported by ITS-LE:
1. Required:
    - a) None
  2. Preferred:
    - a) Refer to current Digital Signage specifications on file with ITS-LE.
  3. Disallowed:
    - a) None.
- G. AV Camera System Standards – MOMS based rooms:
1. Required:
    - a) All cameras shall be certified as Lenel compliant to current USC and DPS Standards. Confirm with ITS-LE at time of install.
    - b) All camera costs must include the server license costs.
    - c) All cameras shall to be mounted in secured and seismically approved mounts.
    - d) All cameras shall be IP (H.264) based, either direct or via camera encoder.
  2. Preferred:
    - a) Use of POE based device preferred where infrastructure will support.
  3. Disallowed:
    - a) None.
- H. AV Audio System Standards:
1. Required:
    - a) None
  2. Preferred:
    - a) Instructional rooms that merit speech reinforcement audio systems are identified in Technology Room Types.
    - b) In auditoria, Public Address (PA) systems should include capabilities to support:
      - a) A hard-wired microphone located at the podium,
      - b) Min of (1) wireless microphone

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- c) Auxiliary input(s) and record output(s) to enable easy audio recording of the speaker.
- c) In addition to standard program audio equipment (e.g., laptops, blu-ray, video tapes, DVDs, etc.) the program audio system should support computer-generated audio (e.g., multi-media presentations) from the podium and other emerging technologies.
- d) Special audio needs required for distance learning/broadcast should be incorporated into the room design with special consideration given to the need for student microphones and audio requirements at the distant site.
- e) Rooms with program audio systems and rooms with PA systems should be controlled by the equipment control touch panel or other button type controls as approved by ITS-LE.
- f) The audio system components will be located in the AV Wallbox systems, in-room equipment closet, teaching podium, projection room and/or control room. These systems should be accessible only to trained technicians and not the general public. Security covers should be used when appropriate.
- g) The audio mixer(s) or mixer/amplifier(s) should provide a minimum of 4 input channels, with plug-in input modules. Preferred standard equipment is Extron Series or newest model. ITS-LE must approve all equipment.
- h) Assisted listening systems should be incorporated into classrooms and auditoria based on federal ADA legislation, local and state regulations for using portable equipment systems in ITS-LE supported classrooms.
- i) Direct, two-way communication between users and the MOMS support services should be included in the design.
- j) An 8-inch full-range speaker should be provided inside the projection booth and/or control room that is tied into the classroom/auditorium sound system for monitoring the audio system from the projection booth.
- k) Full control over the room's audio sound system should be available in any projection booth/control room either via direct room control or web based.
- l) A master volume shut off control of sound reinforcement/program for public address audio during fire alarm shall be provided.
- m) The auditorium speaker system should be carefully designed for the space to provide uniform coverage over the entire seating area of the room/auditorium for both sound reinforcement and program sound reproduction.
- n) Provide flush mounted, 70V distributed ceiling loudspeakers in sufficient quantity to provide appropriate SPL levels for the space.
- o) Room Signal-to-Noise requirements will determine if speech reinforcement is required but in general, rooms with 35 or more seats require (1) wireless microphone system integrated into AV Wall Box system.
- p) Smaller rooms (below 20 seats) do not require microphones unless they include additional technologies such as lecture capture, videoconferencing, etc.
- q) Provide ALS output in classrooms where microphone systems are installed, or as required to meet current ADA standards, whichever is greater.
- r) In spaces that accommodate more than 60 occupants, ALS shall be a fixed with min. (2) available headsets available in all auditoria or as required to meet current ADA standards, whichever is greater. ITS-LE provides ALS meeting these requirements in all Auditoria.

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- s) Room sound issues to address include ST ratings between walls and areas above ceiling with no plenum barrier.
  - t) Provide (1) XLR Balanced and Unbalanced output at specified locations for lecture capture capabilities.
  - u) Provide (6) XLR Balanced output on wall plate.
3. Disallowed:
- a) None.
- I. AV Control System Standards:
- 1. Required:
    - a) None
  - 2. Preferred:
    - a) Current supported ITS-LE AV Control System standard in all ITS-LE MOMS managed spaces is based on the Extron control system and Metacontrol platform.
    - b) Any system such as AMX and Crestron to be supported by ITS-LE will require integration into the ITS-LE enterprise Metacontrol system, Extron GVE.
    - c) Non-Extron based designs should be reviewed by ITS-LE for compatibility of systems with the ITS-LE standards in metacontrol and metadata requirements.
    - d) Any equipment and room control system will be determined based on existing systems supported by ITS-LE and the specific controls needs for the individual classrooms.
    - e) Level "D" type of spaces. Other, more basic systems are also used for smaller, less complex equipment rooms and may be proposed for consideration by ITS-LE staff.
    - f) Instructional rooms that merit equipment and room controls are identified in Technology Room Types and shall be reviewed by ITS-LE id spaces are to me managed and controlled by MOMS.
    - g) Rooms with equipment control systems should include infrastructure to support primarily a hardwired touch panel (in the podium or a wall mounted application). Addition of wireless remote control units to be evaluated by ITS-LE. Wireless units require a storage location in the room, such as podium or wall, that can be secured and that provides power to recharge the remote's batteries.
    - h) AV touch panels (to control lights, motorized screens, and other remotely controlled equipment), shall be located either on a podium, or wall location, as specified by ITS-LE staff.
  - 3. Disallowed:
    - a) None.
- J. Enterprise Metacontrol - MOMS Standards:
- 1. Required:
    - a) The USC MOMS system is critical to the workflow and success of the spaces ITS-LE creates and manages. For this reason, integration to the Extron GVE Enterprise AV Control and Data System is required if a location is to be supported by ITS-LE.

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- b) As part of the design process, ITS-LE considers the end users, day-to-day use and supports in context of the enterprise and will identify the specific needs of any system in context of the enterprise strategy.
  - c) A primary consideration for any AV system design should be to determine the Metacontrol context of the application and the operations support services requirements.
  - d) Communication Devices/ Help Phones: As part of the standard AV Wallbox system, the devices support hands-free calling to any university extension and to take incoming calls. Phones can dial out to 911 and be used in reverse 911.
  - e) Any MOMS support space shall follow current USC access control standards. Current standards are on file with CCD. Locks are controlled as a part of the MOMS application interface.
2. Preferred:
- a) AV Designers should be free to select the best solution that fits the specific control system scenario. If the space is intended to be ITS-LE MOMS supported, system designs should conform to the Extron control system either directly by use of Extron products or by hard/soft interface allowing for metadata control and data collection.
3. Disallowed:
- a) None.
- K. Room Design Standards:
- 1. Required:
    - a) None
  - 2. Preferred:
    - a) General
      - a) Classrooms should be buffered from internal building noise (e.g., student lounges/vending machine areas) and exterior building noise (e.g., loading docks.)
      - b) Adequate power and data shall be located in classrooms and other spaces.
      - c) Classroom corridor doors should have noise reduced closure mechanism to minimize disruptive noise from doors opening and closing during sessions. With doors, consider ability to prevent light from outside the room striking the projection screen.
      - d) Hallway floors and room entrances shall be barrier-free to comply with ADA requirements and allow free movement of AV support equipment carts.
      - e) Built-in corridor/lobby seating, adjacent to classrooms, should be included per program to encourage small group discussions and pre- and post-class group interaction. These spaces might include LCD displays and/or writable surfaces.
      - f) An open “front” area of the room shall be clearly defined. Class/Seminar/Breakout rooms are generally recognized to be either rectangular or almost square with a clear distinction of a “front” of the room to accommodate the ITS-LE support technology. While rooms



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may be considered to be flexible and reconfigurable in regards to furniture, the technology is fixed.

- g) Technology should be designed with the length dimension of the room approximately 1.5 times the width dimension. (Rooms wider than they are long provide unacceptable viewing angles for projected media.)
- h) No seat shall be more than 45 degrees off the center axis of a classroom to ensure adequate viewing to the chalk/white board(s) and projection screen(s).
- i) ITS-LE managed spaces (i.e., classrooms, breakout rooms, seminar rooms, computer classrooms, case study rooms, and auditoria) are also categorized into technical room types by:
  - 1. The level of technology provided in the space(s)
  - 2. The levels of on-site support to include the portability or permanence of equipment in the room and levels of will-call support.
  - 3. The requirements for ITS-LE MOMS remote managed support services.
- j) All technology-enabled spaces must plan for ongoing support of the technology at some level either via internal departments or reliance on external service such as ITS-LE MOMS.
- k) Instructors must be able to obtain/use media/data from sources located outside the physical constraints of the classroom, generally display/share media and/or data with their students and engage students in active exchanges. Spaces shall have robust wired and wireless data offering.
- l) General education technology enhanced rooms cannot be categorized solely on room configurations (e.g., whether the room is a seminar room or an auditorium) but are classified on room functionality. There are generally three layers of infrastructure to support room functionality and support services:
  - 1. Infrastructure associated with local implementation of classroom equipment and technologies within a given space (e.g., displays, projectors, screens, cameras, speakers, etc.)
  - 2. Infrastructure associated with building wide implementation of current and future multi-media and digital equipment and technologies, (e.g., sound systems, PA/voice-enhancement, microphones, video/data display equipment, program playback equipment, etc.
  - 3. Infrastructure required for integrating each room and building control points to the campus-wide MOMS support enterprise wide systems.
- m) ITS-LE MOMS Technical support for classrooms may include:
  - 1. Centrally located control room that serves a cluster of classrooms within a building
  - 2. Master control room that serves multiple locations, spaces, etc.
  - 3. No local MOMS control and support with all services outsourced to current ITS-LE support services.
- b) Room Finishes

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- a) Painted surfaces in classrooms should be durable to reflect the high occupancy and usage of these learning spaces.
  - b) The reflectance values and color schemes for classrooms should be developed in conjunction with ITS-LE. General guidelines for reflectance values of all surfaces should be considered in design.
  - c) Floors in ITS-LE managed classrooms should be hard surfaces or carpeted. Selection of flooring should include consideration of sustainable products, acoustic properties of the flooring, and ease of maintenance by cleaning staff.
  - d) Chair rails should be applied to classrooms with moveable tables and/or chairs. Rails should match the architectural design of the room and installed to match the standard height of chairs (approximately 25-27" AFF.)
- c) Furniture Guidelines:
- a) In general avoid center aisles to provide the maximum seating area with the best viewing angle.
  - b) In classrooms with fixed seating, stagger the seats to provide clear viewing angles.
  - c) An area of the room shall be kept clear of seating to provide adequate space for a teaching area for the instructor. Provide adequate area for the instructor to have free movement around the front of the room with access to the chalk/white boards, audio-visual equipment, lectern/podium, equipment control system, lighting controls, etc.
  - d) Provide an area to accommodate the ITS-LE standard podium, table, chair and audiovisual equipment as specified by ITS-LE. The front area should be large enough to give a minimum of 42" for instructors to stand behind the podium and/or desk and still allow free movement of students between the front of the podium/desk and the seats.
  - e) The students shall have a clear view of the instructor, projection screens or displays at all times. The instructor should be able to connect with and hear any student in the room during presentations (including multi-media presentations), discussions and lectures.
  - f) The furniture type for classrooms can vary depending on the size of the room and pedagogical needs of the instruction. Major selection criteria for selecting classroom seating includes comfort, durability, ease of maintenance and availability of spare parts. General guidelines for furniture selection include:
    - 1. Rooms with more than 60 seats should have sloped or tiered floor unless otherwise noted.
    - 2. Fixed or folding tablet arms should have a writing or laptop surface. Power should be consider in accommodating student BYOD (bring your own device) technology.  
A defined amount of seats shall have tablet arms that accommodate left-handed people per current ADA and State of California requirements.
    - 3. Stations for disabled students (wheelchair bound students) shall be provided per current ADA and State of California requirements.

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4. Classrooms will provide height adjustable instructor tables and height adjustable seating.
  - g) The last row of fixed seats shall have a minimum clearance of 6 inches from the back of the seat to the last riser/wall to accommodate installation of the furniture and audiovisual inputs as needed.
  - h) Fixed strip tables shall be a minimum of 18 inches deep with modesty panels. Seat spacing shall be a minimum of 24 inches from seat center back to seat center back.
  - i) The provision of appropriate power should be considered for all table types and room configurations.
- d) Windows and Window Treatments
  - a) Windows and natural light are highly desirable in classrooms.
  - b) When windows are present in classrooms, they should be located on a side of the room, never at the front or the rear.
  - c) All windows in classrooms must be provided with sufficient window treatments (blinds, shades, drapes, etc.) to eliminate most outside light from reaching the projection screen. Complete blackout shades are not required unless for specific purpose. Auditoria should not have windows (with the exception of the projection booths).
- e) Security Guidelines:
  - a) Classrooms, supporting spaces and equipment in classrooms must be designed with security issues in mind.
  - b) Personal security for students and instructors is essential in design of classrooms. Consideration must be given by the design team to ensure the safety of the room occupants and the safety of the surrounding environment.
  - c) Classrooms should be included in any electronic keying system designed for the overall building. Any electronic locking system must allow for flexible schedules to accommodate special weekend events, evening events and non-scheduled maintenance access to the rooms.
  - d) Keying for locking equipment closets, podium, projection booths, equipment storage and other ITS-LE controlled support spaces must be designed with input from staff from ITS-LE during the Design Development stage of the project.
  - e) Current keyway for all keys used to open locking equipment closets, podium doors and drawers, projection booths and storage spaces is on file.
- f) MOMS TYPE A: Basic Technology Room – no AV Wallbox
  - a) “Standards based” MOMS enabled Type A spaces are often, but are not exclusively, associated with smaller instructional spaces such as open collaborative areas, seminar rooms, conference rooms and breakout rooms where limited technology/equipment/interface is generally available.
  - b) The primary functionality of the room or space is non-technology based (e.g., discussions, collaboration, work study, etc.) In addition to installed projection screens or flat panel displays, the in-room

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- equipment may be limited and may consist only of AV interface for user provided cables and devices.
- c) Type A spaces generally will not have an AV Wall box based equipment control systems but would likely contain motorized screens or shades, appropriate lighting controls, or built-in data projection equipment and program sound equipment.
  - d) Technology in these spaces includes:
    - 1. Refer to Standard wall designs on File.
    - 2. (1) 60" – 70" flat panel display.
    - 3. (1) Display Mount.
    - 4. (1) Extron AV Button controller.
    - 5. (1) AV Interface with analog and digital inputs.
    - 6. (1) Ceiling Loudspeakers – as required.
    - 7. (1) MOMS Support camera.
    - 8. (1) Mac or PC for interactive software support.
  - e) Permanent infrastructure includes: (Refer to current published drawings for standards)
    - 1. Single Display Wall (60" to 70") backing infrastructure – drawings on file with CCD.
    - 2. Appropriate power outlets and communication/data outlets.
    - 3. Conduit pathway from any rear, side and front walls to stub above ceiling.
    - 4. Conduit pathway from wall/ceiling mounted flat panel monitor (at max. 72" AFF).
    - 5. Audio/video interface outlets (at 18" AFF).
    - 6. Audiovisual button control outlets (at max. 48" AFF).
    - 7. Conduit pathway from room to main building cable tray for data to master switches.
    - 8. MOMS camera infrastructure including power and data. Cameras to be located and focused to maximize the viewing area where the audiovisual services are to be supported.
  - f) Other considerations include:
    - 1. Minimum NC ratings: Refer to Acoustical section of these guidelines.
    - 2. Type A rooms should have standard white/chalkboards/IdeaPaint, window shades to control ambient light and general room lighting controls with controls to minimize light onto projection surfaces.
    - 3. In addition to wall power outlets, "A" type rooms may have co-located floor power outlets. Appropriate connections, pull boxes, equipment support brackets. Future provisions to be considered with assessing such pathways above ceiling, under floors backing infrastructure.
    - 4. Conduit and box sizes should correspond to the Infrastructure summary found elsewhere in this document.
  - g) MOMS TYPE B: Standard Technology Room – Single AV Wallbox

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- a) Level B, “MOMS Enhanced Service – AV Wall Box” based classroom, can typically be described as general education classroom that meet USC’s technology requirements including ITS-LE defined technology structure required for support. These classrooms are generally rectangle or square, ranging from small 20-seat classrooms to larger 75+ classrooms. All ITS-LE supported spaces are equipped with the Single AV Wallbox (see item f below) with clearly defined standards and no deviation unless approved.
- b) The room technology includes permanently installed Single AV Wallbox housing all equipment and the connectivity needed for multi-media presentations, audiovisual control and support communications. The AV Wallbox is the recognized standard teaching station. The box location is the local control point for classroom infrastructure and is the general connection point for the room’s internal and external infrastructure.
- c) The control-center for in-room equipment will be located within the AV Wallbox. The AV Wallboxes contain instructor-operated equipment (VCR/DVD or Blu-Ray) as well as systems equipment required to control, manage and monitor the devices within the AV Wallboxes (e.g., control equipment, audio amplifiers, power and data, etc.).
- d) The primary attributes of the Type B room include the ITS-LE standard AV Wallbox with all defined user equipment and room control systems, permanently installed data/video projector with motorized 16:10 projection screen or flat panel display and distributed program. Larger capacity rooms will also include speech audio reinforcement including output for portable based Assistive Listening System (ALS) systems.
- e) Any required equipment closets, including the teaching podiums, should be sized to hold standard rack-mounted equipment components. Any equipment closets should be either recessed in a convenient location for access to internal equipment.
- f) Essential elements for AV Wallbox include:
  1. Standards based Single AV Wallbox with defined backing infrastructure.
  2. End-user connectivity and provided Blu-Ray player.
  3. Extron digital based AV control and audio systems.
  4. Handsfree Communications device
  5. Lighting switches – Lutron or as specified
  6. Screen Control switches – Low voltage screen switch
  7. Electronic Lock system
- g) In addition to the Wallbox, the following should be provided:
  1. (1) 60” x 96” 16:10 motorized wall or ceiling screen
  2. (1) Pair of Ceiling Speakers meeting appropriate SPL standards
  3. (1) Additional AV Input location if needed
  4. (1) Approved MOMS camera, mounting, infrastructure and licensing. Cameras to be located and focused to maximize the viewing area where the audiovisual services are to be supported.
- h) Permanent infrastructure includes:

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1. Power outlets and communication outlets within AV Wallbox location as defined.
  2. Conduit pathway from front/rear wall interfaces to front wall.
  3. Conduit pathways to permanently installed audio-video equipment such as data projectors and flat panels.
  4. Conduit pathways to support portable and/or permanent camera locations.
  5. Power to support portable or BYOD (Bring your own device).
- i) Other considerations include:
1. Minimum NC ratings: Refer to Acoustical section of these guidelines.
  2. All “B” Type rooms should have standard chalk/white board/IdeaPaint or combination, window shades, general room lighting with ability to control lighting at projection surface(s).
  3. In addition to wall outlets, all “B” Type rooms should have co-located wall/floor power/communication outlets to support portable and BYOD devices.
  4. Power to support ceiling mounted video/data projector and other in-room equipment or furnishings (e.g., document cameras, motorized projection screen, motorized marker boards, motorized window coverings, etc.).
  5. Conduit and low voltage wiring to support public address system and podium microphone (large or noisy rooms only).
  6. Equipment/conduit to support stereo sound or higher quality system for program audio systems. Could include wall mounted program speakers and ceiling mounted speech reinforcement speakers.
  7. Appropriate connections, pull boxes, equipment support brackets.
  8. Conduit and box sizes should correspond to the Infrastructure summary found elsewhere in this document.
- h) MOMS TYPE C: Standard Technology Room – Dual AV Wallbox
- a) Type C “MOMS Enhanced Rooms – Dual AV Wallbox” classroom, can typically be described as a classroom that include dual projection and ability to display multiple sources with AV touch control system and supporting hardware in dual AV box design. These classrooms are typically found in larger sized rooms, ranging from small 30 to 60 seat classrooms. The technology package in these type rooms includes the ITS-LE approved Dual AV Wallbox design - The room technology includes The Single AV Wallbox with components as outlined above with additional 2nd lower AV Box that contains AV control hardware that is permanently installed in addition to the equipment for multi-media presentations and infrastructure for ad hoc lecture capture. Additional attributes of the room Type rooms include Extron touch panel control, ceiling mounted permanently installed data/video projectors, motorized projection screens, confidence/collaboration displays, audiovisual inputs in various locations and required program and speech reinforcement audio support.

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- b) The control-center for in-room equipment is to be located at the AV Wall box location above second box as outlined in Drawings of File. Due to functionality requirements, Type C rooms require a Graphical Touch Panel. The AV Wallbox contains instructor operated equipment (e.g., Blu-Ray & Inputs) as well as systems equipment (e.g., control equipment, amplifiers, microphones, etc.)
- c) The AV Wallbox wall location acts as the local control point for classroom infrastructure and is the general connection point for the room's internal and external infrastructure such as power and data. For all current infrastructure
- d) Equipment closets, if required to support additional technologies beyond what is included in the AV Wallbox, should be sized to hold standard rack-mounted equipment components. Equipment closets should be either recessed in a convenient location for access the internal equipment.
- e) Essential elements for Dual AV Wallbox include:
  - 1. Single AV Wallbox with second lower equipment box.
  - 2. Extron Touch panel controller.
  - 3. Extron digital based control and audio systems.
  - 4. End user connectivity (HDMI & VGA)
  - 5. Blu-Ray player.
  - 6. Handsfree Communications device; requires analog phone line.
  - 7. Lighting switches – Lutron or as specified
  - 8. Screen Control switches – Low voltage screen switch
  - 9. Data locations to support technology.
  - 10. Electronic Lock system with security locking hardware, keyed to ITS-LE keys specifications.
- f) In addition to the Wallbox, the following should be provided:
  - 1. (2) Projection Screens: 60" x 96" or next size up to meet design standards.
  - 2. (2) Collaboration LED/LCD displays with local inputs and control
  - 3. (2) Pair of speech/program ceiling speakers
  - 4. (1) Additional AV Input location if needed
  - 5. (1) Approved MOMS camera, mounting, infrastructure and licensing. Cameras to be located and focused to maximize the viewing area where the audiovisual services are to be supported.
- g) Permanent infrastructure includes:
  - 1. Power outlets and communication outlets.
  - 2. Appropriate floor boxes to support power, data and audio-visual equipment at Instructor's podium. Larger rooms may require a podium location a distance from Wallbox.
  - 3. Conduit pathway from front, side or rear wall locations as needed to support interface locations.
  - 4. Conduit pathways to support MOMS camera and permanently installed audio-video equipment (e.g., data projectors, flat panel displays, etc).
  - 5. Conduit pathways to support portable and/or permanent cameras.

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6. Power to support any VC or LC lighting needs.
  7. Conduit pathways from podium floor box to equipment closet(s) if applicable and to building cable tray system.
- h) Other considerations include:
1. Minimum NC ratings: Refer to Acoustical section of these guidelines.
  2. Type C rooms should have standard chalk/white boards and/or IdeaPaint, window shades, general room lighting as described above.
  3. In addition to wall power outlets, “C” level rooms can have co-located floor power/communication outlets to support portability and mobility with BYOD’s.
  4. Power to support ceiling mounted video/data projector, flat panel displays, cameras and other in-room equipment or furnishings (e.g., document cameras, motorized projection screen, motorized marker boards, motorized window coverings, etc.).
  5. Conduit and low voltage wiring to support public address system where required.
  6. Equipment and supporting conduit to add wall mounted program speakers in larger rooms.
  7. Appropriate connections, pull boxes, equipment support brackets.
  8. Conduit and box sizes should correspond to the Infrastructure summary found elsewhere in this document.
- i) TYPE D: Distance Learning/Lecture Capture, Specialty Room
- a) Distance Learning/Lecture Capture or specialty” spaces are designed to meet all multi-media requirements as detailed above but that add additional capabilities requiring specific technologies beyond what may be found in standard general education spaces. These classrooms may be associated with larger spaces but like the “Enhanced Technology” rooms, these can be found in all shapes sizes.
  - b) Other differences between Level “A-C” and Level “D” rooms may be in the acceptable noise levels (NC 30-35 vs. 20-30), special lighting and the permanently installed equipment to support technologies such as videoconferencing and lecture capture, pathways and ancillary equipment for the needed activity.
  - c) Additional attributes of Type D rooms may include equipment and room control systems, permanently installed data/video projectors, flat panel displays, presenter and audience microphones, document cameras, inputs for permanently installed cameras to support activity, capture microphones, etc.
  - d) As in Type “C” rooms, the control-center for in-room equipment may likely be the AV Wallbox systems, equipment closet and/or teaching podium designed to contain instructor operated equipment such as Blu-Ray, as well as system control equipment (e.g., touch panels, interface equipment, amplifiers, microphones, etc.) Any required control-center is to be located in an adjacent control room that is sized appropriately to support the number of spaces in the building.



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- e) The AV Wallbox or in-room equipment closets act as the local control point for classroom infrastructure and intended to be the general connection point for the room's internal and external infrastructure. Equipment closets should be recessed into the front wall of the room and sized to hold standard rack mounted equipment components.
- f) Essential elements for DL/LC based rooms include:
  - 1. Single or Double AV Wallbox design based on requirements.
  - 2. Extron Button or Touch panel based control.
  - 3. Security hard locking hardware, keyed to ITS-LE requirements.
- g) In addition, the following should be provided:
  - 1. When rack used: Pull-out racks for equipment maintenance.
  - 2. Security locking hardware, keyed to ITS-LE keys sequence.
  - 3. (1) 60" – 70" flat panel display.
  - 4. (1) Display Mount.
  - 5. (1) AV Interface with analog and digital inputs.
  - 6. (1) Ceiling Loudspeakers – as required.
  - 7. (1) Approved MOMS camera, mounting, infrastructure and licensing. Cameras to be located and focused to maximize the viewing area where the audiovisual services are to be supported.
  - 8. (1) Mac or PC for interactive software support.
- h) Permanent infrastructure includes:
  - 1. Power outlets and communication outlets.
  - 2. Appropriate floor boxes to support power, data and audio-visual equipment at instructor's podium.
  - 3. Conduit pathway from front, side and rear walls to control locations (AV Box or closet).
  - 4. Conduit pathways to support equipment control system, permanently installed audio-video equipment (e.g., data projectors, etc.).
  - 5. Conduit pathways to support permanently installed cameras.
  - 6. Conduit and cabling for student 2-way videoconferencing microphones.
  - 7. Conduit pathways from podium floor box to equipment closet(s) to Control Rooms and building cable tray system.
  - 8. Conduit and pathways for power at all seat locations.
- i) Other considerations include:
  - 1. All "D" Type rooms should have appropriate NC noise levels. Refer to Acoustical section of these guidelines.
  - 2. All "D" Type rooms should have standard chalk/white boards, window shades, general room lighting, etc.
  - 3. Special consideration should be given to room finishes (to reduce glare and provide greater acoustical properties) necessary for quality broadcasting.
  - 4. In addition to wall outlets, all "D" level rooms should when possible have co-located floor power/communication outlets to support portable and BYOD equipment.

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5. Provide power to support ceiling mounted video/data projector and other in-room equipment or furnishings (e.g. motorized projection screen, motorized marker boards, motorized window coverings, etc.).
  6. Provide conduit and low voltage wiring to support public address system/broadcast audio via microphone or wireless microphone.
  7. Provide equipment/conduit to support high quality stereo sound system for program audio systems.
  8. Provide power to support VC/LC quality lighting.
  9. Conduit and box sizes should correspond to the Infrastructure summary found elsewhere in this document.
  10. In some cases, Level “D” rooms will also include conduit to individual seat locations for power and data connections.
- j) AV Support Equipment Closets
- a) Equipment closet(s) may be required in Level “B”, “C” and D type rooms as noted in Technology Room Types.
  - b) The equipment closet(s) acts as a hub for the internal room infrastructure. Conduits ranging in size from 1-inch to 2-inch in diameter will run from equipment in the room (i.e., from the podium, the ceiling data projector, speakers, flat panel displays, cameras.) to the cabinet(s), closets or podium. Sufficient space must be provided to accommodate the necessary conduit to support ITS-LE requirements.
  - c) As the room/area/building hub, the equipment closet(s) will also have conduit to support rooms such as projection, control room, or master control rooms located outside the classroom but needed to support technology activities.
  - d) The number and size of the closets will be determined by the number of equipment items to be housed. Typically, rooms will require one closet to accommodate the equipment. If multiple closets are needed interconnecting conduit is required between the closets.
  - e) The exact size of the closet will be determined in conjunction with the design team and ITS-LE. Minimum width and depth clearance of the closet will be sufficient to hold a sliding, 24”-wide equipment rack that is extended for maintenance.
  - f) The equipment closet(s) should be recessed into the wall with the front door flush with the room wall. An instructor should be able to quickly move from behind the podium to the equipment closet without crossing the entire front of the room. If possible, rear access from the corridor is desirable for equipment maintenance.
  - g) Doors for the closet(s) should be standard 1-hour rated doors with secure locking mechanisms to prevent theft of the equipment. The closet(s) should be keyed per ITS-LE instructions.
  - h) Lock sets for equipment closets: Reference submittals.
  - i) Equipment needed by the instructor (e.g., Blue Ray player etc.) should be located separately from the systems equipment (e.g., mixers, amplifiers, etc.) Access to the systems equipment is limited to ITS-LE technical staff and not to instructors/students and thus should be keyed differently from the user accessible equipment.

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- j) In rooms with a single equipment closet, the control equipment and instructor equipment should be separately located within the closet. The closet should secure the control equipment separately from the instructor equipment.
  - k) Sufficient power to operate a fully loaded equipment rack should be provided on back wall of equipment closet.
  - l) A communications/Ethernet outlet (adjacent to power), should be provided on back wall of equipment closet.
  - m) Cooling should be provided based on a fully loaded and operating equipment rack. Electronic equipment located in the closet cannot be cooled sufficiently by general room air-flow and requires mechanical cooling.
  - n) Temperature inside closet with equipment powered and running and doors closed and locked should equal ambient air temperature inside the instructional room within 5-7 degrees F.
  - o) Standard rack unit ventilation spaces are required between each unit mounted in the rack. Equipment must be mounted with security screws. Equipment should also be secured with padlocked security cables to prevent theft.
  - p) Rack units should be securely fastened into the equipment closet. Rack units must have slide-out capability to allow service to back of equipment. Units must also include secure cable management system to allow equipment to slide out for maintenance.
  - q) Equipment within the rack units must be secured with security screws and, if needed, separately cabled with security cables to prevent thefts.
  - r) Prior to installation all equipment serial numbers, Mac Hardware addresses, manufacturer information and model information must be provided to ITS-LE Technical staff in an easy to use electronic spreadsheet for inventory purposes.
- k) Equipment Storage Rooms
- a) In new construction, a dedicated A/V equipment storage room may need to be provided to support ITS-LE managed spaces. Any ITS-LE equipment storage room is to be separate and securable room. The room shall be approximately 100 square feet in total size with a height clearance of 7 feet throughout the space (no low beams or duct work). The minimum acceptable dimension of the storage room is 7 feet by 14 feet; 10'x10' or 12'x8' is preferred.
  - b) The equipment storage room shall be located as close as possible to the main concentration of technology-supported rooms in the building.
  - c) An ITS-LE storage room should have fluorescent lighting and ventilation. The door into the storage room should be wide with the door swinging out to allow for maximum storage within the room.
  - d) Provide direct access to the storage room from a public hallway; avoid storage rooms opening off classrooms or other normally occupied rooms. All instructional equipment storage rooms shall be keyed to ITS-LE equipment master key sequence, not the building master key. A minimum of 4 keys per room shall be provided to ITS-LE staff.

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- l) Projection Booths
  - a) Auditoria may contain a projection booth at the rear of the room to support front projection. Rear projection designs must be reviewed and approved by ITS-LE staff prior to inclusion in the building design.
  - b) Projection booth walls shall be constructed to meet STC-50. Booth minimum size of is 10 feet wide by 6 feet deep. Booth entrance shall be ADA accessible. Entrance to booth should be without entering main auditorium seating areas.
  - c) Projection Booths must be locked with system to accommodate ITS-LE key system as specified during Design Development stages of the project.
  - d) The booth shall have a single projection window, min. of 32-inches high and as wide as practical. The window shall be centered on the projection screen with the windowsill at 48-inches AFF. The window glass shall be made of ¼-inch (minimum) float glass and placed perpendicular to the floor.
  - e) The projection booth shall have a projection shelf for equipment. The shelf shall be constructed of 1 ½-inch thick plywood (or equivalent) and be a minimum of 24 inches deep. The shelf shall run the entire length of the projection window and be supported by a minimum of three support points. To reduce glare, the shelf shall be finished with a matte finished dark colored plastic laminate.
  - f) The front edge of the shelf (nearest the glass) shall be even with the windowsill. A minimum 3- inch space should be included between the front edge of the shelf and the wall for cables.
  - g) Provide a second shelf below the projection shelf at 12 inches AFF for equipment storage.
  - h) Provide a separate, lockable storage cabinet that is at minimum 12 inches high by 48 inches long by 24 inches deep for expensive and/or portable equipment. Key this cabinet separately from the projection room lock.
  - i) Extend a surface metal raceway, equivalent to Wiremold 3000, the full length of the wall below the projection shelf at 24-inches AFF with 4 evenly spaced quad receptacles.
  - j) The center two receptacles should be on one dedicated 20 amp circuit and the outside two receptacles on a separate relay-controlled dedicated 20 amp circuit. (Note: All receptacles should be relay controllable, if desired by ITS-LE staff.)
  - k) Provide a duplex receptacle located away from the shelf and door for equipment not located on the shelf (e.g., audio system components) and a double duplex receptacle centered on the rear wall of the booth (all at 18-inches AFF) on a third dedicated 20 amp circuit.
  - l) Extend a separate surface metal raceway at 30 inches AFF, equivalent to Wiremold 3000 or low voltage wiring. The raceway should extend the full length of the wall below the projection shelf and connect with terminal cabinet. Conduit and box sizes should correspond to the Infrastructure summary found elsewhere in this document.
  - m) The terminal cabinet should be located on the wall opposite the booth door. The cabinet should be a minimum of 30 inches wide by 42

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inches high by 6 inches deep. The cabinet should have a lockable door to limit access to controls and equipment. The cabinet should be provided with a relay controlled dedicated 20amp circuit.

- n) The projection booth should have two lighting systems, a general fluorescent system for maintenance and set up, and a dimmable downlight system for use when the learning space is darkened. The downlights should be mounted near the front wall and designed to concentrate light on the projection shelf without shining into the audience. The manual dimmer switch should be located so an equipment operator can reach it without leaving the equipment. The dimmer switch should be located as far away from the terminal cabinet as possible to reduce interference.
  - o) A breaker panel, classroom control cabinet, and note taking light motorized dimmer should be located on the back wall of the projection booth, with the dimmer at the opposite end of the room from the terminal cabinet to reduce interference.
  - p) Preferred equipment for relay cabinet is GE RB-3 (or larger as required). Preferred equipment for motorized dimmer is Lutron MCD-120-2000 (2000 watt) or newest model approved by ITS-LE technical staff.
3. Disallowed:
- a) AV Equipment may not be located in any Electrical Room or Electrical Closet.

### L. Podiums / Lecterns

- 1. Required:
  - a) No Requirements.
- 2. Preferred:
  - a) Podium should be based on standard USC "smart podium" design. Line drawings are available from ITS-LE. Design consultants may add architectural design features as long as technical requirements for the podium are met.
  - b) The podium typically should be located on the instructor's left side (when facing the class) and angled toward the opposite rear corner of the room, to allow the instructor to face the audience, use the chalk/marker board and still view the projection screen. The podium should not block the students' view.
  - c) The teaching podium should be secured in its location but designed to enable ITS-LE or authorized staff to move the podium for maintenance. If feasible provide retractable wheels. Provide adjustable leveling feet for podium.
  - d) The bottom interior of the podium is open to allow access to standard University podium floor box(es). Sufficient clearances are required to allow power cables, communication cables, audio and video cables to transit from the podium to the floor box receptacles without crimping cables.
  - e) The room control touch panel (if applicable) should be located in a moveable section that can be set on a lower table for ADA compliance. The panel will be hinged to allow instructors to select the appropriate panel-viewing angle.

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- f) Standard connector panels located on the podium top should contain Ethernet outlets, audio connections for microphone, aux in, record out, PC and/or Mac laptop plug-in outlets.
  - g) A duplex power outlet should be provided on the top surface of the podium.
  - h) Typical podium will have four (4) locks:
    - a) front door (on the instructor's side of the podium);
    - b) back door (on the audience's side of the podium);
    - c) external drawer
    - d) internal drawer compartment.
  - i) Detailed information on the locks and appropriate keying must be obtained from ITS-LE during design development.
  - j) Approved tabletop lecterns should be provided Level "A" classrooms in lieu of "smart" podium. Refer to current ITS-LE Furniture guidelines.
3. Disallowed:
- a) None.
- M. Chalk / Markerboards
1. Required:
- a) No Requirements.
2. Preferred:
- a) A combination of chalkboards, Writable paints and marker boards (i.e., IdeaPaint and white" boards) are used in ITS-LE supported spaces. ITS-LE staff will specify writing surface guidelines during the design stage of the project.
  - b) All chalk/marker boards will include a tack strip along the top edge and chalk/pen tray at the bottom edge. Paint surfaces will include tray portions at specified locations on wall surfaces.
  - c) Writing surfaces should be a minimum of four feet high with the bottom edge of the tray 36 inches AFF.
  - d) Sliding boards are acceptable up to three boards deep (i.e. one stationary and two sliding sections) to increase the overall amount of board space available for instructors.
  - e) Chalk/marker boards in larger auditoria may be supported with image magnification (iMag) high resolution cameras.
  - f) Portable chalk/marker boards are not generally permitted in USC general access rooms unless provided by FPM Facilities.
  - g) A portion of the total writing surface should be uncovered and available for use by the instructor when the projection screen(s) are lowered.
  - h)
3. Disallowed:
- a) None.
- N. AV Infrastructure Standards:
1. Required:
- a) Infrastructure & Backing Details
    - a) Details are on file with CCD for the following.

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1. Single AV Wall Box design
  2. Double AV Wall Box design
  3. Collaboration Display Wall design
  4. Digital Signage Wall design
  5. Ultra-Short throw projector design
  6. AV Interface, standard wall plate design
- b) Conduit
- a) Use EMT for all runs over 72".
  - b) Flexible conduit shall be acceptable for use in walls and other fully accessible spaces when appropriate.
  - c) Provide AV Input/Power/Data Assembly at location defined in provided details.
    1. (1) Power – quad (¾" EMT)
    2. (1) AV – Single gang mud ring (1) 1 ½" EMT stub to ceiling
    3. (1) Data – quad (1) 1 ¼" EMT stub to ceiling
  - d) At mud-ring opening, leave any AV conduits cut min. of 1" above mud-ring opening to allow for smooth cable radius into opening.
- c) AV Interface:
- a) General placement – center of wall unless otherwise indicated.
  - b) Infrastructure minimum requirements for all locations based on standard Double Gang 4S electrical box and Interface Plate.
  - c) (1) Double gang mud opening at 18" A.F.F with AV mud ring provided
  - d) (1) 1 ½" EMT conduit stubbed at 20" A.F.F. VERIFY
- d) Wall Boxes
- a) Only ITS-LE approved AV Wall Boxes shall be acceptable for use in MOMS supported spaces.
  - b) Any non-standard AV boxes will require approval by ITS-LE.
  - c) Any design changes to AV Box standards shall be reviewed and approved by ITS-LE.
- e) Plenum spaces
- a) Generally acceptable to Free-Run plenum rated cable in open space on approved J-Hooks.
  - b) For projectors, provide (1) 1 ½" EMT conduit to projector pull box locations from AV Wall Box conduit stubs at ceiling as needed.
- f) Cabling and Equipment Plant
- a) A separate equipment and cable plant design is required for ITS-LE managed rooms. Designers/Consultants/Integrators will work with ITS-LE to complete designs including a matrix or schedule of room types and technical categories, functional equipment required by room and line drawings of the AV system.
  - b) The integrated purchase/install contractor will purchase all equipment as specified by ITS-LE and design consultant, install all equipment and systems, test equipment and systems and train ITS-LE technical staff on operation and maintenance of the equipment and systems.

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- c) All equipment and cable will meet standards as specified by ITS-LE staff and design consultant. All substitutions must be approved prior to installation. All requests for substitution must include an on-site test of the actual equipment requests by the contractor.
- d) All audiovisual cabling will be U.L. approved and be free of defects and splices.
- e) HDMI cables and devices in the chain should be consistent to manufacturer specifications.
- g) Communications
  - a) Systems supported by ITS-LE must comply with ITS-LE standards and specifications defined in the Voice/Data/Video Communications standards section.
  - b) Standard USC ITS communications outlets are required in all spaces and rooms.
  - c) All rooms will have a minimum of two standard outlets. The priority for locations in classrooms is as follows:
    - 1. At AV Wallbox – Refer to Submittals
    - 2. Wireless access points as defined by ITS.
    - 3. At equipment closets, or if not applicable at the projection booth
  - d) Any AV IP devices that require Internet connectivity must be connected directly to the USC network. No intermediary switches are allowed.
- h) Power
  - a) Provide power as specified to AV Wallbox wall locations.
  - b) Power should be located approximately  $\frac{3}{4}$  of the screen width from the front wall.
  - c) Add duplex power at specified ceiling mounted projector locations.
  - d) If two projectors or document cameras are specified with a single screen, locate the power approximately  $\frac{1}{4}$  the screen width on each side of the center of the screen.
- i) Future Provisioning:
  - a) At any location where there will be future provision of AV at minimum, provide:
    - 1. 1  $\frac{1}{2}$ " EMT stub to ceiling
    - 2. (1) Quad CAT6 outlet
    - 3. (4) CAT6 cables
    - 4. (1) 1  $\frac{1}{2}$ " EMT stubbed to ceiling.
    - 5. Provide a single location for each 28 feet of wall or where design calls.
    - 6. Any backing required for future Flat Panel displays, reference provided backing detail.
    - 7. All conduits specified shall be EMT or Ferrous Metal type.
    - 8. Flexible conduits may be used in runs of 72" or less.
    - 9. Flexible conduits shall not be allowed where access cannot be provided to the full length of the conduit.



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10. At accessible ceiling locations, conduits shall be stubbed from wall to accessible ceiling. At accessible ceiling locations cable shall be free run and supported with J-Hooks.

2. Preferred:
    - a) No Preference.
  3. Disallowed:
    - a) None.
- O. Quality Assurance requirements:
1. Required:
    - a) No Requirements
  2. Preferred:
    - a) All installation fabrication and construction shall comply with manufacturer's recommendations and industry standard best practices.
    - b) All installed audio-visual equipment and control systems shall be reviewed with ITS-LE technical staff under normal working conditions to ensure acceptable functional performance of the equipment and installation.
    - c) Non-functioning equipment and systems shall be repaired and testing repeated at no expense to the University until acceptable results have been achieved.
    - d) ITS-LE will receive all relevant project and system records for archival into USC systems. This includes final drawings, systems drawings, CAD, Revit models, manuals, etc. These are to be delivered electronically as defined by ITS-LE standards.
  3. Disallowed:
    - a) None.
- P. Design Review Package requirements:
1. Required:
    - a) Schematic Design Phase: Provide 1/4" scale plans and elevations indicating concept and configuration of classrooms.
    - b) Design Development Phase: Provide 1/4" scale plans and elevations indicating complete classroom design including, but not limited to, technology level facilities, acoustical considerations, special systems (e.g. AV system), equipment locations, communications, lighting and power. Outline specifications.
    - c) Construction Document Phase: Complete design and final specifications.
  2. Preferred:
    - a) No Preferences
  3. Disallowed:
    - a) None.

### 3. PRODUCT REQUIREMENTS

- A. AV Control and Automation Systems:
1. Manufacturers:

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- a) Required:
    - a) Extron (for systems requiring MOMS support)
  - b) Preferred:
    - a) Extron – Primary
    - b) AMX - Secondary
  - c) Disallowed:
    - a) None
2. Component Characteristics:
- a) Required:
    - a) Connectivity to the Enterprise AV Control and Data System (Extron GVE – Global Viewer Enterprise) is required if a location is to be supported by ITS-LE
  - b) Preferred:
    - a) No preferences.
  - c) Disallowed:
    - a) None.
- B. Projectors, Data/Video, Classroom:
1. Manufacturers:
- a) Required:
    - a) No requirements.
  - b) Preferred:
    - a) Panasonic
    - b) Christie
    - c) Epson
  - c) Disallowed:
    - a) None.
2. Component Characteristics:
- a) Required:
    - a) DLP or LCD technology
  - b) Preferred:
    - a) No preferences.
  - c) Disallowed:
    - a) None.
- C. Projectors, Large Venue:
1. Manufacturers:
- a) Required:
    - a) No requirements.

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- b) Preferred:
    - a) Panasonic
    - b) Christie
  - c) Disallowed:
    - a) None.
  - 2. Component Characteristics:
    - a) Required:
      - a) DLP or LCD technology
    - b) Preferred:
      - a) No preferences.
    - c) Disallowed:
      - a) None.
- D. Mounts, Projector:
- 1. Manufacturers:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) Chief
    - c) Disallowed:
      - a) None.
  - 2. Component Characteristics:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) Ceiling tile with approved seismic strapping.
      - b) Pole mount – secondary options as project requires
    - c) Disallowed:
      - a) None.
- E. Mounts, Security:
- 1. Manufacturers:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) Projector: BMS Inc. (LOC II Type)
      - b) Display mounts – Chief, Premier, Custom
    - c) Disallowed:

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- a) None.
- 2. Component Characteristics:
  - a) Required:
    - a) No requirements.
  - b) Preferred:
    - a) .
  - c) Disallowed:
    - a) None.
- F. Projection Screens:
  - 1. Manufacturers:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) Da-Lite
      - b) Draper
      - c) Stewart
    - c) Disallowed:
      - a) None.
  - 2. Component Characteristics:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) Screen Gain: 1.0
    - c) Disallowed:
      - a) None.
- G. Flat Panel Displays:
  - 1. Manufacturers:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) Classrooms: Sharp PN-E Series
      - b) Collaborative spaces: Sharp PN-E Series
      - c) Digital Signage/other: Varies based on application
      - d) Auditoria: Samsung, Sharp, NEC
    - c) Disallowed:
      - a) None.
  - 2. Component Characteristics:

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- a) Required:
    - a) Commercially rated unless otherwise specified.
  - b) Preferred:
    - a) No Preferences
  - c) Disallowed:
    - a) None.
- H. Audio Amplifiers:
- 1. Manufacturers:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) Extron MPA Series
      - b) Integrated amplifiers in Extron AV switchers
    - c) Disallowed:
      - a) None.
  - 2. Component Characteristics:
    - a) Required:
      - a) Commercially rated unless otherwise specified.
    - b) Preferred:
      - a) No preferences.
    - c) Disallowed:
      - a) None.
- I. Assisted Listening Systems:
- 1. Manufacturers:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) Listen technologies
      - b) Sennheiser
    - c) Disallowed:
      - a) None.
  - 2. Component Characteristics:
    - a) Required:
      - a) FM or IR.
    - b) Preferred:
      - a) No preferences.

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- c) Disallowed:
  - a) None.
- J. Audio Loudspeakers:
  - 1. Manufacturers:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) Ceiling Mount: Extron Flat Field speakers FF120, FF220
      - b) Wall mounted: Extron, JBL, Tannoy
    - c) Disallowed:
      - a) None.
  - 2. Component Characteristics:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) No preferences.
    - c) Disallowed:
      - a) None.
- K. Communications Device, handsfree:
  - 1. Manufacturers:
    - a) Required:
      - a) Viking K-1700-3 Phone.
    - b) Preferred:
      - a) No preferences.
    - c) Disallowed:
      - a) None.
  - 2. Component Characteristics:
    - a) Required:
      - a) Vandal Resistant Phone
    - b) Preferred:
      - a) No preferences.
    - c) Disallowed:
      - a) None.
- L. AV Wall Boxes:
  - 1. Manufacturers:
    - a) Required:

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- a) Single – B&G Millworks
      - b) Double – B&G Millworks
    - b) Preferred:
      - a) No Preferences
    - c) Disallowed:
      - a) None.
  - 2. Component Characteristics:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) No preferences.
    - c) Disallowed:
      - a) None.
- M. Dry Erase Marker Surfaces:
  - 1. Manufacturers:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) Idea Paint Create
      - b) Wall Talkers
    - c) Disallowed:
      - a) None.
  - 2. Component Characteristics:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) No preferences.
    - c) Disallowed:
      - a) None.
- N. Multi-Media Furniture:
  - 1. Manufacturers:
    - a) Required:
      - a) No requirements.
    - b) Preferred:
      - a) Lecterns – DWI Furniture and B&G Millworks
      - b) Podiums – DWI Furniture

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- c) MOMS Master Control Station - Winstead or similar
- c) Disallowed:
  - a) None.
- 2. Component Characteristics:
  - a) Required:
    - a) MOMS Master Control Station - min 72" surface, for up to (3) 24" Ergotron mounted displays
  - b) Preferred:
    - a) No preferences.
  - c) Disallowed:
    - a) None.

**END OF DOCUMENT**



# USC DESIGN GUIDELINES

## 27 4143 HEARING ASSISTANCE SYSTEMS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
1. For auditoriums, dining facilities, large classrooms, large conference rooms where hearing assistance is required.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
x	x		x

### 2. PROCEDURAL REQUIREMENTS

- A. Description of the System:
1. Perimeter Loop: a double loop around the perimeter of the seating area to be installed under existing / new carpet. The induction loop will use a special flat cable specifically for under carpet installation. A conduit penetration shall be provided between the location of the head end equipment / control room and the loop area to allow passage of the induction loop cabling.
  2. Carpet:
    - a) For existing carpet, the carpet will be taken up and layed down again after installation of the induction loop. This will include cleaning up carpet glue in the cable pathway to ensure the cable lays flat. In some locations it may be necessary to remove and replace the fixed seating to facilitate installation of the induction loop.
    - b) For new carpet, the carpet to be layed down after the installation of the induction loop.
  3. Induction Loop Driver: The induction loop driver will be installed in an equipment rack, preferably one existing in the main AV equipment location. The input of the driver will be wired in parallel with any existing RF hearing assistance transmitters, where applicable.
- B. Warranty:
1. Equipment including solid-state devices shall be warranted free of defects for a minimum period of 1 year from date of acceptance.
  2. Maintenance service for a period of 1 year after acceptance testing shall consist of a minimum of 2 semiannual visits to the site for checking and adjustment of equipment.
  3. 4 hour telephone warranty service, with 48-hour on-site technical response time shall be included. Technician shall be on call from 7am – 7pm 7 days a week.

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### 3. PRODUCT REQUIREMENTS

#### A. Performance Standards

##### 1. Power Amplifiers:

- a) Input: balanced, bridging, furnish transformer if required for balancing or to eliminate hum.
- b) Output: impedance and power as designated in drawings, do not ground common, do not combine commons of amplifiers.
- c) THD: less than 0.1%, 30-20,000 Hz
- d) Dynamic range: at least 110 dB
- e) Response: +/- 1 dB, 20-20,000 Hz

##### 2. Audio Amplifiers and Signal Processors:

- a) Input: balanced, bridging, furnish transformer if required for balancing or to eliminate hum.
- b) Output: balanced, 600 ohm, transformer. Equipment having provision for plug-in transformers shall have transformers installed; otherwise external transformers shall be installed.
- c) THD: less than 0.05%, 30-20,000 Hz, +18 dBm
- d) Dynamic range: at least 90 dB
- e) Response: +/- 1 dB, 20-20,000 Hz

##### 3. Microphones:

- a) Output: balanced, floating, nominal 150 ohms
- b) Portable wired units with 12' to 18' cord terminated in male XLR-3 connector with pin 2 positive
- c) Wireless microphone receiver with 3' cord terminated in male XLR-3 connector with pin 2 positive

##### 4. Safety Laboratory Listings: equipment powered from the mains shall be labeled as listed by a testing laboratory acceptable to the City of LA.

#### B. Audio Transducers

##### 1. Induction Loop Driver

- a) Manufacturer: Listen ILD 500 or equal
- b) Input: Line level 1/4", -30dBu
- c) Current Output: 6.4 Amps RMS, 1kHz continuous sine wave
- d) Drive Voltage: 31.8V at maximum current output
- e) Frequency Response: 80 Hz to 6.5 Hz, +/- 3dB
- f) Distortion: <0.2% THD+N, 1kHz sine wave at full current
- g) Coverage: 14,000 square feet with 3:1 aspect ratio loop
- h) Provide metal loss correction control to adjust frequency response to compensate for metal in the loop environment
- i) Provide rack mounting ears, as required.

##### 2. Induction Loop receiver (IL RCVR)

- a) Manufacturer: Listen LP-IL-1 or equal induction loop receiver with lanyard and headphones
- b) Output: 110 dBa maximum with a 16 ohm load
- c) Connector: 3.5mm jack
- d) Volume control with on/off switch
- e) Frequency Response: 80 Hz to 6.5 Hz, +/- 3dB
- f) Distortion: <0.5% THD, 1kHz sine wave

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- g) Provide one single ear speaker and one stereo headphone for each receiver
  - h) Provide battery for each receiver
  - i) Provide carrying case for all receivers
  - j) Minimum quantity (10)
3. Carrying Case
- a) Manufacturer: Pelican, Masco or equal
  - b) Watertight plastic equipment case
  - c) Polypropylene Structural Resin case material
  - d) Neoprene Sponge O-rings to seal lid
  - e) Provide 1.7 lb/cubic foot foam inserts with custom sized cavities for each receiver, as required
  - f) Size to accommodate the induction loop receivers in a single case
- C. Racks, Wire, Connectors, and Misc Hardware
1. Rack Panels – Blank Panels
- a) 1/8" anodized brushed aluminum finish
  - b) 18" standard EIA width
  - c) Manufacturer: Middle Atlantic or equal
2. Rack Panels – Vent Panels
- a) 16 gage perforated steel with black power coat finish
  - b) 60% minimum open area
  - c) 19" standard EIA width
  - d) Manufacturer: Middle Atlantic or equal
3. Rack Kit(s)
- a) 1/6" anodized brushed aluminum finish
  - b) Custom manufacturer for each piece of equipment
  - c) 19" standard EIA width
  - d) Manufacturer: Middle Atlantic or Manufacturer's rack kit.
4. Installed Wiring – Induction Loop Output - Standard
- a) Pre-manufactured cables with molded consumer grade connectors shall not be used.
  - b) 14 AWG stranded THHN cable, PVC jacket
  - c) Color: Provide separate colors for individual loops (red for first loop, green for second, etc)
  - d) Manufacturer: Listen LA-396-14 or equal
5. Installed Wiring – Induction Loop Output – Under Carpet Flat Wire
- a) Pre-manufactured cables with molded consumer grade connectors shall not be used.
  - b) Flt copper cable covered in polyester film designed specifically for use under floor coverings
  - c) Cross sectional area: .71" x .00039"
  - d) Manufacturer: Listen FB1.8 or equal
6. Installed Wiring – Mic and Line
- a) Pre-manufactured cables with molded consumer grade connectors shall not be used.
  - b) Shielded pair #22
  - c) Manufacturer: Belden 8761, West Penn 291 or equal
7. Wire Labels
- a) Permanent cables marked with typed wire labels at both ends of the cable. Hand written labels are not permitted.

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- b) Utilize plastic shrink wrap, protecting the text and ensuring labels remain affixed to the wire
- 8. Connectors – Mic and Line XLR type
  - a) 3-pin female XLR type cable end. Manufacturer Switchcraft A3F, Neutrik NC3FX or equal
  - b) 3-pin male XLR type cable end. Manufacturer Switchcraft A3M, Neutrik NC3MX or equal
  - c) 3-pin female XLR type panel. Manufacturer Switchcraft D3F, Neutrik NC3FP or equal
  - d) 3-pin male XLR type panel. Manufacturer Switchcraft D3M, Neutrik NC3MP or equal
- 9. Connectors – Induction Loop Output
  - a) Manufacturer: Neutrik Speakon devices only. No equal.
  - b) Cords: NL4FC
- 10. Concrete Sealant
  - a) Manufacturer: Glidden Gripper or equal
  - b) To be applied to concrete floor surface prior to application of Flat Insulated Copper Wire
- 11. Spray Adhesive
  - a) Manufacturer: 3M Super 77 or equal
  - b) Spray adhesive to affix Flat Insulated Copper Wire to a concrete floor
- 12. Installation / Warning Tape
  - a) Manufacturer: Listen PWT Adhesive Installation/Warning Tape or equal
  - b) Adhesive tape to cover and secure installed Flat Copper Wire
- 13. Wire Clamp
  - a) Manufacturer: Richco N series or equal
  - b) Material: nylon, UV stabilized
  - c) Color: Black
  - d) Size: holding diameter sized as required based on conductor size
- 14. Wire Harness Cover
  - a) Manufacturer: Techflex Flexo PET or equal
  - b) Exposed wiring (i.e. wiring from AV plates to fixed equipment) shall be bundled together and covered with a flexible expandable mesh covering to protect the cables. Wire harness covering shall be sized as required to accommodate each cable bundle.
  - c) The ends of the mesh covering shall be dressed at each end of the cable length using shrink wrap plastic tubing.
  - d) The cable harness shall be black. Provide a sample to the Owner for review and approval prior to installation.
- D. Signage
  - 1. Signage submittals shall be submitted to FPM Engineering for approval before ordering.
  - 2. The sign must contain the International Symbol of Access for Hearing Loss (“Logo”, CBC 11B-703.7.2.4): See Exhibit.
    - a) “T” included when induction loop is installed.
    - b) “T” omitted when induction loop is not installed.

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3. At the bottom of the symbol, the sign shall contain the words:
  - a) "Assistive-Listening System Available"
4. The sign shall be:
  - a) Approximately 8" wide x 10" high. Size may vary according to size of lettering.
  - b) Background color shall match wall color. If wall color does not allow for contrast with lettering color, background color shall be white or off-white.
  - c) Logo and lettering color: Approved RGB Conversion R153 G27 B30  
Approved HEX: #990000.
  - d) Lettering:
    - i. Typeface shall be: National
    - ii. Letter size be not less than 5/8" high, plus 1/8" per foot over 72" distance from sign.
5. Mounting:
  - a) Sign shall be mounted at the main entrance, clearly visible in an area with no less than 4" clear in front of the sign.
  - b) The bottom edge of the sign to be not less than 40" and not more than 70" from the ground. Height to be dictated by viewing space.
  - c) If an induction loop is present, an additional sign with the "T" included (2.a above) shall be mounted adjacent to the induction loop controller.

### 4. INSTALLATION REQUIREMENTS

- A. Accessibility shall be maintained at the rear of equipment racks and around all equipment.
- B. Equipment rack wiring shall be "harness" style. "Point to point" rack wiring is not acceptable.
- C. Provide a separate wiring harness for each service level. Service levels shall not be mixed in an individual harness. Low level signal harnesses shall be separated from the AC power lines and high level signal harnesses by a minimum of 12 inches.
- D. Rack mounted equipment shall be labeled on front and back, as to function, using engraved black/white laminated plastic blocks.

### 5. EVALUATION or COMMISSIONING

- A. System Performance Tests
  1. The Contractor shall pre-assemble and test the systems in the Contractor's facility before completed assemblies are delivery to the project site.
  2. Tests shall include those listed below in order to verify that the system meets the design requirements.
  3. The Contractor shall perform the system testing and adjustment of the installed systems prior to scheduling the final system acceptance observations.
  4. The tests shall be fully documented and a neat copy presented for review by the Owner during the acceptance observation and a copy of the test results shall be included in the system manual.
- B. Performance Tests on Individual Components:

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1. Perform in the Contractor's facility.
  2. Verify that the manufacturer's specifications are met.
  3. Verify the operation of all equipment prior to delivery to the jobsite.
- C. Performance Tests on the Complete System:
1. Verify that the wiring is correctly and completely installed. Verify that there are no short circuits between conductors within a cable, or from cable to cable. Verify the integrity of each conductor, i.e., that the conductor is not open circuited. In addition, the correct polarity of each connector shall be verified and the color-coding scheme shall be recorded and included in the documentation provided to the Owner.
  2. Verify the induction loop continuity and separation from ground.
  3. Verify that the entire system performance is in accordance with the design requirements and IEC 60118-4.
  4. Provide test equipment.
  5. Field Strength Meter: Tests on the completed installation shall be made with a field strength meter. The meter shall have the following characteristics:
    - a) Class 2 meter per IEC 61672-1.
    - b) A-weighted background noise measurement range of -42 dB to -12 dB, minimum.
    - c) Field strength measurement range of -22 dB to +8 dB.
    - d) Frequency band measurements with 1/3 octave frequency bands centered at 100Hz, 1kHz and 5kHz, at a minimum.
    - e) Headphone output to monitor incoming signal.
      - a) Meter shall be calibrated to read 0 dB at 400mA/m per IEC 60118-4
    - f) The test results shall be recorded and provided as part of the As-Built Document Submittal.
    - g) The outlined tests, and others that the Contractor may wish to perform for his own satisfaction, shall be performed successfully before the observation is requested. The Owner may request repetition and demonstration during observation of certain of these tests or other critical tests if problems become apparent. If specifications are not met, further observations will be at the Contractor's expense.
- D. DEMONSTRATION AND ACCEPTANCE OBSERVATION
1. Acceptance Observation:
    - a) The Contractor shall file a written notice with the Owner when the Aids to Use have been submitted for approval, the System Tests are complete and the system is ready for the Acceptance Observation.
    - b) The Contractor shall be prepared to demonstrate the overall system performance. In addition, the Observation of the systems may include repetition or demonstration of System or other critical tests if problems become apparent and the specifications are not met. After the Observation, written notice noting whether the systems meet the criteria set forth in the Contract for Substantial Completion, along with a list of items for the Contractor to correct shall be provided to the Contractor.
    - c) The Contractor shall assist in the observation by performing demonstration tests and final system adjustments. Provide the labor, materials and tools necessary for these tests and adjustments. Provide necessary test equipment to complete the tests.
  2. Contractor Participation in the Observations:

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- a) The Contractor shall make one representative during the system observation. They shall assist the Owner in performing the observation. The Contractor shall demonstrate the performance of the system by carrying out tests on the system as directed by the Owner and making final system adjustments as deemed necessary.
  - b) The Contractor shall provide labor, materials and tools necessary to repeat or carry out System Tests during the observation and to make adjustments to the system during the observation.
  - c) The Contractor shall budget a minimum of 4 hours for the observation. If additional time is required for the observations because the system installation is not complete or system testing or adjustment has not been completed, the Contractor shall solely bear the cost for additional man hours necessary to complete the inspections.
  - d) System testing and adjustment shall be completed prior to the observation.
3. Acceptance:
- a) After observations and tests indicate that the entire system as specified are in compliance with the drawings and specifications, a letter indicating said compliance shall be issued.
  - b) Acceptance of the system shall be accomplished as described in the Contract.
  - c) Final acceptance of the installation will be granted when it is clear to the Owner that the following conditions have been met:
  - d) Equipment has been provided according to the drawings and specifications.
  - e) Portable equipment has been turned over to the Owner.
  - f) The installation has been tested and shown to perform as specified.
  - g) The instruction manuals, software source code and as-built documentation have been completed and delivered to the Owner.
4. The Warranty period will begin only when the above criteria have been met.

### E. TRAINING

1. Submit the training materials to the Owner for approval prior to scheduling training sessions.
2. Provide 2 hours of hands on training practical operation of the system to the Owner. Address in the training, the general configuration of the system, basic functionality, correct operation procedures, routine maintenance and upkeep.

### 6. **EXHIBIT:** Signage Specifications

Logo and lettering color: Approved RGB Conversion R153 G27 B30. Approved HEX: #990000.  
Typeface: National (Letter size be not less than 5/8" high, plus 1/8" per foot over 72" distance from sign.)

10 inches



5/8 in.  
min.

**Assistive-Listening  
System Available**

8 inches



# **USC DESIGN GUIDELINES**

**END OF DOCUMENT**

**28 08 00 FIRE DETECTION AND ALARM  
COMMISSIONING REQUIREMENTS**

**1. OVERVIEW**

- A. Purpose: USC requirements for fire alarm system commissioning (Cx) are indicated in this document. Fire detection and alarm commissioning will be required at the discretion of the university.
- B. For other related requirements, refer to
  - 1. Section 01 19 13 General Commissioning Requirements
  - 2. Section 28 31 11 Digital Addressable Fire Alarm Systems

**2. COMMISSIONING TEAM**

- A. Team Members:
  - 1. Owner: The Owner shall be the University of Southern California (USC) and its designated personnel. Principal team members for the fire alarm Cx for USC shall be as follows:
    - a. USC Project Manager (USC PM)
    - b. USC Cx Manager (USC Cx)
    - c. Fire Safety Program Manager (FSPM)
    - d. A representative of the University's Operations and Maintenance staff is also a member of the commissioning team.
  - 2. Architect and Design Engineers (A/E): This shall be the design team that will be contracted directly by USC to provide a detailed design for a project.
  - 3. Commissioning Authority (CxA): This will be an experienced individual who is a member of an organization or team that has experience providing the primary aspects of building commissioning.
  - 4. Fire and Life Safety Commissioning Agent (FCxA): This shall be an individual who has demonstrated experience, licenses, and/or certifications with providing Cx services for fire alarm and associated life safety systems.
  - 5. Contractor Team:
    - a. General Contractor (GC or Contractor)
    - b. Mechanical Contractor (MC),
    - c. Electrical Contractor (EC)
    - d. TAB representative
    - e. Controls Contractor (CC)
    - f. Fire Alarm Contractor (FAC)
    - g. Elevator Contractor (ELC)
  - 6. Authority Having Jurisdiction (AHJ): This shall be the lawfully charged agent of the city, county or state agency that holds primary responsibility for providing system acceptance and Certificate of Occupancy.

### 3. FCxA Qualifications and Contracting

#### A. Qualifications:

1. The FCxA shall possess one or more of the following licenses or certifications along with the required work experience.
  - a. Fire Protection Engineer (FPE) with five (5) years documented experience working with fire alarm and other electronic life safety systems.
  - b. National Institute for Certification in Engineering Technologies (NICET), Level IV in Fire Alarms with five (5) years reviewing and/or commissioning fire alarm systems of comparable size and scope of the subject project.
  - c. International Code Council: Both of the following designations are required along with five (5) years of documented experience with reviewing and/or commissioning fire alarm systems of comparable size and scope of the subject project.
    - 1) Commercial Fire Alarm Plans Examiner II (FAPEII)
    - 2) Commercial Fire Alarm Inspector (FAI)
2. During the Request for Qualifications (RFQ) and/or the Request for Proposal (RFP) associated with contracting the FCxA, a complete and detailed resume shall be furnished with the response.
  - a. The resume shall include at least three (3) representative projects similar to the subject property within the last five (5) years, and shall include contact information.
3. The Owner shall reserve the right to deem the submitted FCxA as being qualified for the subject project.
4. Contracting (*TBD*):
  - a. The FCxA may be contracted in one of two ways at the discretion of the Owner.
    - 1) As a team member contracted by or as an internal resource of the CxA.
    - 2) Direct contract with the Owner. When a direct contract is the chosen method, the CxA, if part of the project, will provide coordination with the FCxA in the same manner as if they were contractually obligated as a team member.

### 4. COMMISSIONING TEAM RESPONSIBILITIES:

- A. The following responsibilities are provided as they directly impact the fire alarm system for the subject project. By no means shall this wording or implied intent of this specification alleviate or relieve any team member from other contractual obligations that may be found elsewhere in the construction documents, i.e. specifications and drawings.
- B. Owner:
  1. USC Project Manager (USC PM): The USC PM shall act as the primary liaison between the Contractor, CxA, design team, and other departments or individuals associated with USC.
    - a. The USC PM shall make available all requested and relevant documentation to the FCxA

- b. The USC PM shall coordinate all interruptions to the campus system(s) beyond the subject project.
  - 2. USC Cx Manager (USC Cx): The USC Cx shall oversee the overall Cx process and ensure that USC's requirements are met.
  - 3. Fire Safety Program Manager (FSPM):
    - a) The FSPM shall review all periodic reports and documentation from the FCxA, and provide commentary back on said reports.
    - b) The FSPM shall provide USC's acceptance of the FCxA's final report and the FCxA's certification that the fire alarm and associated systems have been commissioned per the associated national standards and locally adopted Codes.
  - 4. A representative of the University's Operations and Maintenance staff may be tasked to witness the FCxA with the field work associated with the commissioning of the fire alarm and associated systems.
    - a. The Owner may, at their discretion, may opt to have the staff person witness the following:
      - 1) Verification of messages at the control panels and/or annunciators
      - 2) Acknowledgement, silencing and resetting of systems
      - 3) Verification of symbols and messages on graphic displays
- C. Architect and Design Engineers (A/E): The Owner typically requires that the fire alarm and associated systems be undertaken from a "design/build" approach by the FAC. The A/E shall provide, minimally, the following:
  - 1. Locations of all primary system components such as FACP, annunciators and NAC Power Supplies
    - a. Fire alarm systems will include emergency communication (ECS) paging microphones/switches and associated components.
    - b. When required, smoke control panel location(s) shall be indicated.
  - 2. Indicate space available for the location of:
    - a. Fire alarm control units (FACU)
    - b. Remote NAC power supplies (NAC)
    - c. ECS remote amplifiers (EAMP)
    - d. This information shall consist of indicating wall locations with available free space (W x H), and plywood backboard.
  - 3. Clearly indicate areas such as walls or ceilings where due to aesthetic concerns fire alarm devices or components should not be placed.
  - 4. Clearly indicate the location of the following system interfaces:
    - a. Emergency Communication Systems (ECS)
    - b. Elevators
    - c. Fire Sprinkler Systems
    - d. HVAC Units
    - e. Fire/Smoke Dampers (FSD)
    - f. Door hold open/closers or magnetic hold open locations
    - g. Suppression systems such as kitchen hoods or clean agent systems
    - h. Emergency power (generator) circuits for powering systems as a secondary power source.



- b. The following are general descriptions of what each team member is required to do, but final direction shall be as indicated in the Cx Plan.
  - 1) Controls Contractor (CC) shall provide confirmation that HVAC units have been shut down via the facility management software.
    - Where smoke control is involved, the control contractor shall assist in verifying that all conditions requiring participation by the HVAC and associated controls are working as intended by the sequence of operation.
  - 2) Elevator contractor shall provide access to the elevator machine room and elevator top of shaft and pit for testing of related fire alarm components, and confirm the correct recall and shutdown of the elevator(s).
  - 3) Fire sprinkler contractor shall activate all associated components of the fire sprinkler system that are either monitored or controlled by the fire alarm system. This shall include fire pump testing when a fire pump is installed.
  - 4) Kitchen hood and/or clean agent suppression system contractors shall simulate activation of all alarm, supervisory and trouble conditions for those systems.
- 4. Fire Alarm Contractor (FAC) shall be 100% responsible for the pre-acceptance testing (see FCxA requirements below), and shall provide the services of at least two (2) technicians during FCxA's FAT.
  - a) The FAC shall provide technicians, certified on the installed system to provide services as follows:
    - 1) Verification of messages at the control panels and/or annunciators
    - 2) Acknowledgement, silencing and resetting of systems
    - 3) Verification of symbols and messages on graphic displays
    - 4) The FAC shall also provide ladders, radios, and aerosol smoke needed for typical fire alarm system testing.
    - 5) Where more specialized testing is required, such as atrium smoke detection or smoke control testing, the FAC shall provide testing equipment as directed by the FCxA in the commissioning specification.
  - b) The FAC shall provide the following reports using the Notifier Verifier Tools:
    - 1) Inspection and Test Report (use Fire Marshal Friendly Report option)
    - 2) Record of Completion
    - 3) Detector Maintenance Report
    - 4) Module Maintenance Report
  - c) The above reports shall be submitted twice to the FCxA:
    - 1) Upon conclusion of the pre-acceptance testing, and with the notification that the FAC is ready for the Cx Testing.
    - 2) Upon conclusion of the Cx Testing.

- F. Authority Having Jurisdiction (AHJ) shall be offered the opportunity to witness the fire alarm system commissioning as part of their acceptance testing. Should they choose to conduct their own separate testing, the contractor team will not be relieved of responsibility for the Cx testing or the AHJ testing.

**5. FIRE AND LIFE SAFETY COMMISSIONING AGENT (FCxA) RESPONSIBILITIES:**

- A. Design Phase: The FCxA conducts a design review of the fire alarm system and associated systems such as EVAC, ECS/MNS, distributed antennae, smoke control, etc... to be commissioned. This review is focused on operability and maintainability of the systems, and for Code compliance to the locally adopted Codes.

- 1. The FCxA shall review the Owner's Project Requirements (OPR) or Design Intent Document (DI), and 28 3100 Fire Detection and Alarm Design Requirements. The FCxA shall then review the Basis of Design document (BOD) which is the A/E's response to the Owner's Project Requirements. The FCxA verifies that the Basis of Design and the design documents meet the Owner's Project Requirements for the fire alarm and associated systems.

- a. The FCxA shall provide review and commentary of design drawings and specifications from the A/E at the following design milestones:

- 1) 100% Design Development (DD): This will be a general review to verify that the A/E is indicating the requirements of 4.C above are being met.
- 2) 75% to 90% Construction Documents (CD) (Note: CD Review is provide as a range where the Review will be completed prior to permit set, bid set or 100% CD.

- b. The FCxA prepares commissioning specifications to be incorporated in the contract documents. The commissioning specifications outline the scope of commissioning for the particular project along with the responsibilities of the Owner, A/E, Contractor Team, and the CxA and its specialist sub-Cx Agents.

- c. The FCxA also prepares a Commissioning Plan. The commissioning plan provides guidance in the execution of the commissioning process. The Commissioning Plan identifies how commissioning responsibilities are distributed, identifying which parties are responsible for producing the various commissioning procedures, reports, owner notifications, and forms required. The Commissioning Plan also includes the commissioning schedule. The Commissioning Plan is a living document that is updated throughout the project.

- 1) The FCxA shall confirm the level of participation in the Cx process by the AHJ, and clearly make known to the A/E what testing requirements will be required by the AHJ beyond the Cx process.

- B. Construction Phase

- 1. Fire Alarm Commissioning Kick-Off Meeting:

- a. Due to the fire alarm and associated systems be a design/build approach, the FCxA shall lead a separate meeting that is





- 1) All appropriate teams members with planned or anticipated participation in the fire alarm Cx process shall attend the meeting.
  - 2) The FCxA shall clearly provide the following during the meeting:
    - Goals of the meeting
    - Schedule for Cx process
    - Deliverables
6. Functional Acceptance Testing (FAT) shall be conducted by the FCxA to meet the following requirements:
- a. 100% testing of all input devices based on the requirements of NFPA 72 or the manufacturer's documentation if the device/component is not specifically addressed in NFPA 72. The following is the minimally acceptable testing method:
    - 1) Manual Pull Station – Activation of manual pull station
    - 2) Smoke Detector – Use of aerosol smoke, acceptable to detector manufacturer.
      - a) The use of a magnet or test switch is not acceptable.
    - 3) Carbon Monoxide (CO) Detector – Use of CO, acceptable to detector manufacturer.
      - a) The use of a magnet or test switch is not acceptable.
    - 4) Duct Smoke Detector - Use of aerosol smoke, acceptable to detector manufacturer, and the use a manometer to verify airflow through sampling tubes.
      - a) The air flow shall be tested at the following percentages of make-up air being introduced into the system: 0%, 25%, 50%, and 100%.
      - b) The use of a magnet or test switch is not acceptable.
    - 5) Heat Detectors shall be tested as follows:
      - a) Restorable, Electronic-Type – Test using heat gun
      - b) Restorable, Mechanical-Type – Test using heat gun
      - c) Non-Restorable, Mechanical-Type – Short contact circuit
      - d) Linear Heat Detection Cable – Test Switch located at end-of-line resistor (EOLR)
    - 6) Input Module shall be tested as follows:
      - a) Sprinkler water flow – By flowing water through inspector's test port at riser.
      - b) Sprinkler Control Valve Switch – By turning hand wheel
      - c) Monitored Systems – Where a system can be activated without undue harm or release of agent, simulate activation of system to activate alarm, supervisory and/or trouble contacts. Only when absolutely necessary, simulate contact closure at EOLR.
  - b. Confirmation of functional controls by a minimum of two (2) of each device type that are designated as part of the "input group" to the control "output zone".
    - 1) Testing shall be based on the requirements of NFPA 72 or the manufacturer's documentation if the device/component is not specifically addressed in NFPA 72.

- c. The notification system achieves audibility requirements as stated in the basis of design documents.
  - d. Where the Basis of Design requires intelligibility of live or recorded messages, ensure that intelligibility is achieved.
7. End of Project Deliverables
- a. The FCxA shall provide the following upon the conclusion of the Cx process:
    - 1) Letter stating that the FAT has been completed, and it shall include the following:
      - a) Name and contact information of FCxA
      - b) All dates that FAT was conducted and indicating what portion of the system was tested on those dates.
      - c) Names of all participants and their roles in the FAT.
      - d) A statement indicating that the system has been tested and found in compliance with the Basis of Design and the local, applicable codes.
    - 2) A System Record of Inspection and Testing shall be submitted, and shall include the following forms as indicated in NFPA 72, 2013:
      - a) Figure 7.8.2(g) - System Record of Inspection and Testing
      - b) Figure 7.8.2(h) – Notification Appliance Supplementary Record of Inspection and Testing
      - c) Figure 7.8.2(i) – Initiating Device Supplementary Record of Inspection and Testing
      - d) Figure 7.8.2(k) – Emergency Communication Systems Supplementary Record of Inspection and Testing
      - e) Figure 7.8.2(l) – Interface Component Supplementary Record of Inspection and Testing

Note: If the Notifier Verifier Tools reports required below comply with the information required in the above reports. Specifically the required edition, the FCxA shall submit a separate letter stating that the above reports are being submitted based upon the reports provided below.
    - 3) The FCxA shall provide the following reports that have been prepared using the Notifier Verifier Tools, and provided by the FAC to the FCxA:
      - a) Inspection and Test Report (use Fire Marshal Friendly Report option)
      - b) Record of Completion
      - c) Detector Maintenance Report
      - d) Module Maintenance Report

**END OF DOCUMENT**

# USC BASIS OF DESIGN

## 28 1000 ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION DESIGN REQUIREMENTS

### 1.OVERVIEW

A.Purpose: USC preferences and requirements are indicated in this document related to access control, intrusion detection, and video surveillance.

B.For other related requirements, refer to all product-based sections, including 28 1300 Access Control, 28 1600 Intrusion Detection, 28 2300 Video Surveillance, and 08 7100 Doors and Hardware.

C.General Overview

#### 1.Terms Overview – Access Control vs. Security

- a) The term “access control” and the word “security” are not interchangeable related to this document.
- b) “Access control” defines a system that restricts access to a facility based on a set of parameters. Access control systems as defined by USC include card reading devices (commonly known as access control), intrusion detection systems, and CCTV systems.
- c) “Security” defines the active monitoring of a system installed in a facility and includes monitoring devices such as motion sensors, horns/strobes on exit doors, and video surveillance system (VSS).
- d) This document covers the access control systems and standards at USC. Refer to the Department of Public Safety (DPS) for security.

#### 2.Types of Access Control Systems

##### a) Overview

- 1) Access control is divided into two categories: external perimeter access control and interior access control.
- 2) Each building achieves perimeter access control through the Lenel OnGuard system, including card readers and cameras.
- 3) The requirements of the card readers and door hardware for external doors are determined by Facilities Planning Management.
- 4) Cameras and locations are determined as necessary by the Department of Public Safety (DPS).
- 5) External perimeter access control is maintained via building time schedules.
- 6) Interior access control and security is determined by the needs of the individual schools, departments, and staff, on a building-by-building basis.
- 7) Design-build installations are not permitted.

##### b) External Perimeter Access Control

- 1) The philosophy of the external access control system is to provide for an open campus feel during the day and to provide a secure campus during nights and weekends.
- 2) External perimeter access control is achieved through the deployment of the Lenel system with campus-wide components and local building components.
- 3) All new access control systems for existing and new buildings must meet the outlined standards.
- 4) External Perimeter Access Control – Lenel
  - i) Specific types of card reader devices are acceptable to interface with the university Lenel system. For related requirements, refer to section 28 1300 Access Control.

## USC BASIS OF DESIGN

- ii) The external system must be designed by a university-approved Security Consultant unless otherwise approved by FPM and Admin OPS IT
  - iii) The external system must be installed per university standards by a university-approved Security Integrator as outlined here.
  - iv) Programming of the system is performed by a university-approved Security Integrator. The vendor must submit program credentials to prove they have the experience.
  - v) Credentialing of the system and the assignment of access levels for cardholders is performed by USCard Services or a designated building occupant using Lenel's Area Access Manager.
  - vi) The cost of the maintenance of the system is the responsibility of the department/school. A university-approved Security Integrator is necessary to work on the system. Facilities Planning Management (FPM) can assist with system maintenance and warranty issues.
  - vii) Depending on the installation and scope of the project, design, and commissioning is provided by a Security Consultant separate from the Security Integrator. Access control – up to FPM; CCTV/Intrusion up to ADMIN OPS IT.
  - viii) See Section 6, Exhibit B for approved Security Consultants and Security Contactors.
- 5) External Perimeter Access Control – Blackboard Transact
- i) This system is being phased out and replaced by Lenel on a project-by-project basis.
  - ii) No new Blackboard Transact systems are being installed.
  - iii) The Blackboard Transact system is managed and maintained by USCard Services. Confirm with FPM and USCard.
  - iv) Being used as a middle man to communicate/verify between StarRez and Persona.
- c) Internal Access Control
- 1) Internal access control can be achieved in several ways and is driven by the occupants' needs.
  - 2) Access control measures range from monitoring doors being held open to adding cameras to monitor personnel entering and exiting the space.
  - 3) Access control and security measures will add cost to the project and will be designed on a case-by-case basis.
  - 4) Depending on the size of the project, the security needs, and the type of system being used, a separate Security Consultant shall be engaged, aside from the Security Integrator, to provide for an engineered solution.
  - 5) Internal Access Control - Lenel

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- i) Additional equipment can be purchased to extend the Lenel system provided for the external perimeter access control of each building into the interior of a building.
  - ii) Specific types of card reader devices are acceptable to interface with the university Lenel system. For related requirements, refer to section 28 1300 Access Control.
  - iii) The system must be designed by a university-approved Security Consultant unless otherwise approved by FPM and - Admin OPS IT.
  - iv) The system must be installed per university standards by a university-approved Security Integrator as outlined in these guidelines.
  - v) Programming of the system is performed by a university-approved Security Integrator. Reference credentials/qualifications.
  - vi) Credentialing of the system and the assignment of access levels for cardholders is performed by USCard Services or a designated building occupant using Lenel's Area Access Manager.
  - vii) The cost of maintenance of the system is the responsibility of the department/school. A university-approved Security Integrator is necessary to work on the system. Facilities Planning Management (FPM) can assist with system maintenance and warranty issues.
  - viii) Depending on the installation and scope of the project, design, and commissioning is provided by a Security Consultant separate from the Security Integrator. The complexity of the system and the number of devices will dictate if a Security Consultant should be part of the project team.
  - ix) See Section 6, Exhibit B for a list of university-approved Security Consultants and Security Integrators.
- 6) Internal Access Control – Schlage AD400 Door Hardware System
- i) For renovations or additions for existing buildings, the Schlage hardware system option, with the complexity of an access control system.
  - ii) Schlage AD400 devices can be installed on a door instead of traditional keyways and handles, allowing for card-restricted access to the desired areas.
  - iii) The Schlage AD400 system includes an online system that connects to the Lenel system or an offline (stand-alone) system with wireless devices that can be locally managed and maintained.
  - iv) Not for new construction.
  - v) Schlage AD400 System – Online
    - a. The Schlage AD online system is an internal access control solution, including wireless readers that communicates with the building Lenel system.
    - b. This solution includes Schlage AD400 door hardware that communicates wirelessly via a PIM (panel interface module).
    - c. The PIM is connected to the Lenel System via the USC network.
    - d. The software for this system is part of the university Lenel enterprise system and can be managed via the Area Access Manager software by the individual department/building.
    - e. The design of the system is done by the Security Consultant.
    - f. The Schlage AD400 lock is installed by the Door Hardware Installer.
    - g. The PIM and PIM Antenna are installed by the Security Integrator.
    - h. The Schlage AD400 lock, PIM, and PIM Antenna are configured and programmed by the Security Integrator.

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- i. The location and quantity of the PIMs are determined by performing a range test by the Security Integrator.
- vi) Schlage AD System - Offline
  - a. Offline access control locks are being phased out and may only be used with direct approval from FPM.
- 7) Internal Access Control – Stairwell Doors
- 8) Internal Access Control – Burglar Alarms
  - i) The stand-alone burglary alarm may also be used for security.
  - ii) These systems are provided by licensed, approved security vendors.
  - iii) These systems, if installed, should be monitored by the Department of Public Safety (DPS); thus, any installed system should be compatible with existing equipment.
  - iv) DPS does not monitor intrusion for offsite buildings (Pasadena, San Diego, etc.). 3<sup>rd</sup> party services, monitors off-site buildings, and dispatches local police.
  - v) These systems are outside the scope of this document.

### 3.Device Locations

#### a) Overview

- 1) Generally, access control devices, such as card readers and cameras, are located on the exterior of buildings or spaces.
- 2) Card readers are used to limit access into a space.
- 3) By Fire Code, card readers cannot be located on the inside of spaces limiting the ability to exit. Everything outside of the scope must be approved by FPM.
- 4) Card readers also cannot be located in areas that create a mantrap and limit the egress of a building or space.
- 5) Panels are located inside the building in the Electrical Room.
- 6) Panels must be installed in spaces not accessible by the public and require a card reader or e-key to secure locations.

#### b) Responsibilities

- 1) All devices shall be located by the Security Consultant based on the needs of the building occupants, site visits, and drawing reviews.
- 2) Review and confirmation of the locations are provided by Facilities Planning Management (FPM) and Admin OPS IT through review of the access control drawings.
- 3) Locations of interior IP cameras shall be coordinated through Information Technology Services (ITS) as part of the IT scope of the project. ITS is responsible for cable infrastructure, not camera locations.
- 4) Locations of E-phones shall be coordinated through the ITS and Admin OPS IT.

### D.Project Overview

#### 1.Project by Scope

- a) The scope of work of each project and the involvement of trades will depend on the size of the project related to the access control requirements.
- b) For projects with larger scopes, including new buildings, major renovations that include the external doors of an existing building, and in some cases, change of use of a building, a Security Consultant shall be part of the consulting team.
- c) For projects with smaller scopes, including minor door changes to existing buildings, an assessment is provided by the Department of Public Safety (DPS), Admin OPS IT, and Facilities Planning Management (FPM). Consultants and contractors are engaged, as necessary.

#### 2.Drawings and Phases

- a) Large Scope Projects

## USC BASIS OF DESIGN

- 1) For projects with large scopes of work, as defined above, the drawings for a project follow those of the project A & E consultants.
  - 2) Architectural backgrounds are provided to the Security Consultant, and a full scope of drawings and specifications for the project are provided.
  - 3) The Security Consultant will follow the phases of the lead consultant and will have drawings included in the standard schematic design (SD), design documents (DD), and construction documents (CD) phases.
  - 4) The Security Consultant will review submittals and perform construction administration duties as per contract.
  - 5) Once brought on board, the Security Consultant will meet with the Users and the Project Manager to assess the needs of the facility.
  - 6) The initial drawings will be reviewed by representatives from the Department of Public Safety (DPS), Admin OPS IT, Information Technology Services (ITS), and Facilities Planning Management (FPM) for compliance.
  - 7) The complete drawing set will then proceed along with the lead consultant's and general contractor's schedules.
  - 8) The Security Consultant will develop a complete permit set of drawings and specifications for bid to a university-approved Security Integrator.
  - 9) Bids to Security Integrators shall follow the standard project's requirements, including interviews, as necessary.
  - 10) The Security Integrator shall be a sub-contractor to the Electrical Contractor. This ensures that the requirements for conduits and wiring are met during the infrastructure work of the contract.
  - 11) Security Consultant needs to be brought on by the University or by a Design Architect.
- b) Small Scope Projects
- 1) For projects with a smaller scope of work, as defined above, Facilities Planning Management (FPM), Admin OPS IT, and the Department of Public Safety (DPS) act as the primary initial point of contact (POC).
  - 2) FPM, Admin OPS IT, and DPS work with the Users and/or the Project Manager to assess the needs and determine a scope of work.
  - 3) FPM and Admin OPS IT will alert the Project Manager as to the need and scope to hire a Security Consultant.
3. Security Consultants and Security Integrators
- a) Security Consultants and Security Integrators are both important parts of the design and installation team but provide separate functions.
  - b) The Security Consultant provides services for the design, engineering, and commissioning of the access control systems.
  - c) The Security Integrator is responsible for the installation and testing of the system.
  - d) The Security Consultant – Overview
    - 1) A university-approved Security consultant should be engaged early in the project's design phase.
    - 2) Security drawings and specifications follow the same project design schedule, with drawing sets being issued during the schematic design (SD), design drawings (DD), and construction document (CD) phases.
    - 3) Security system design includes coordination with the electrical drawings, as conduits are provided as part of the electrical system as well as the architectural drawings related to doors and hardware.
    - 4) Early coordination allows for accurate costs and budgeting for both the security and electrical systems.

## USC BASIS OF DESIGN

- 5) Security drawings should also be included with the architectural and electrical sets to be provided to the City for permitting.
  - 6) As part of the commissioning phase of the project, the Security Consultant will oversee the installation, provide punch lists, and oversee the end-to-end system commissioning.
  - 7) Security Consultant shall submit drawings to Admin OPS IT for their review/approval.
- e) The Security Consultant – University Approval
- 1) Requirements
    - i) All Security Consultants must be approved by the university prior to being awarded a project.
    - ii) Eligible Security Consultants shall provide qualifications to FPM, including copies of personnel and credentials, in addition to completing the university applications.
  - 2) Minimum Qualifications
    - i) Table 1 below provides the minimum qualifications necessary to qualify as an approved Security Consultant.
    - ii) Admin OPS IT and FPM will determine if the qualifications are sufficient.

Certification / Organization	Staff Member – Minimum Amount
Certified Protection Professional (CPP) Credential	1
Physical Security Professional (PSP) Credential	1
Certified Security Consultant (CSC) Credential	1
NICET Video Security System Designer Certification	1
International Association of Professional Security Consultants (IAPSC) member	1
ICA Certified CPTED Practitioner Program for Individuals (ICCP)	1

- 3) Approved List
    - i) See Section 6, Exhibit B for approved Security Consultants.
- f) The Security Integrator – Overview
- 1) The Security Integrator is hired to install the designed access control system.
  - 2) The Security Integrator is responsible for acquiring the necessary hardware and equipment and making all final system connections.
  - 3) The Security Integrator is also responsible for communications through the project process with Admin OPS IT to program the devices of the system and ensure a complete and working system is delivered. The Security Integrator needs approval from Admin OPS IT prior to programming.
  - 4) All services to be provided by the Security Integrator are part of the security specifications (as provided by the Security Consultant).



## USC BASIS OF DESIGN

- 5) The Security Integrator is responsible for functional testing of the system once installed, for involvement during the commissioning process, and for all adjustments that need to be made after the system has been commissioned.
- g) The Security Integrator - Approved by FPM and Admin OPS IT
  - 1) Requirements
    - i) Security Integrators must be approved by the university prior to being awarded a project.
    - ii) Eligible Security Integrators shall provide qualifications to FPM & DPS, including a list of Lenel certifications and experience, including the master certified programmers on staff, in addition to completing the university applications.
    - iii) At a minimum, the Security Integrator shall hold the legally required California State Contractor's licenses necessary to accomplish the installation and activation of the system, as well as to submit drawings to the City of Los Angeles.
    - iv) The Security Integrator shall also be a permanent organization approved by and in good standing with Lenel for the purchase and installation of its products.
  - 2) Approved List
    - i) See Section 6, Exhibit B for approved Security Contractors.

### E. System Overview

#### 1. System Philosophy

- a) The intent of the access control system is to provide for a controllable perimeter of a building that can satisfy the needs of the building occupants.
- b) All exterior doors must be hardwired and under the control of the access control system.
- c) This allows for additional flexibility, especially during emergency situations.
- d) Some doors are equipped with the ability to enter and exit all the time using card readers.
- e) Some doors are equipped with the ability to enter and exit only during certain times.
- f) Some doors are for emergency exits only and are equipped with monitoring devices.

#### 2. Electronic Access Control System (EACS)

- a) The EACS is comprised of a wide-area data network, server, administrative and monitoring clients, communications client, remote system controllers, and card readers compliant with the campus credentialing system.
- b) The existing EACS system is a Lenel OnGuard PROsystem, providing access control services, with USCard Systems providing global credential database services to the EACS.

#### 3. Credentialing System

- a) The credentialing system is designed to provide credentials for faculty, staff, students, support, and administrative personnel.
- b) The system is managed by USCard Services or individual departments, depending on the building/facility.
- c) The Security Integrator is responsible for the access level creation, the initial time schedule setup, schedule for all new installations, and inputting the first 50 cardholders. Security Integrators need to consult with FPM and Admin OPS IT prior to the access level creation. For additional cardholders, PM will contact Admin OPS IT and/or FPM for direction.
- d) Maintenance and management of the credentialing system becomes the responsibility of the individual department or building manager.
- e) Where a new device is being added to an existing system, the Security Integrator is responsible for updating the new reader with the existing database and time schedule.

## USC BASIS OF DESIGN

### 4.Video Surveillance System (VSS)

- a) The digital surveillance system is manufactured by Genetec.
- b) The system is LAN network-based and uses digital video servers, network recording media, and video management software.
- c) The VSS is integrated with the access control system (Lenel OnGuard Edition)

### 5.Emergency Assistance Stations (EAS)

- a) Emergency Assistance Stations shall be coordinated through ITS.
- b) An ITS ticket shall be submitted through ServiceNow for new and replacement EA Stations.
- c) For new construction projects, 4 new EA Stations must be accounted for. This quantity may be reduced during the design phase approvals.
- d) For existing construction builds, older model and outdated EA Stations shall be replaced with new ones, to meet these requirements.
- e) Emergency Assistance Stations shall have an overlooking CCTV camera mounted above to provide situational awareness.

## F.Coordination with USC

### 1. Facilities Planning Management (FPM)

- a) FPM is the university department responsible for the operations and maintenance of all university buildings.
- b) Related to access control, FPM is responsible for overseeing the maintenance of the system's hardware.
- c) FPM determines the standards for installation, including the wiring of the doors and door frames, types of wires used, and equipment mounting.
- d) FPM reviews all phases of the access control documentation for compliance with installation standards, doors, hardware coordination, and equipment locations.

### 2.Department of Public Safety (DPS) & Admin Operations IT (Admin Ops IT)

- a) The mission of DPS is to support the university's academic, social, and economic goals by recruiting and developing employees of the highest quality, promoting a safe and secure environment, and preserving the university's reputation and assets.
- b) DPS's primary goal is to provide a safe and secure environment in which the social and academic endeavors of the university community may be fully realized.
- c) Admin OPS IT is responsible for assessing and approving the locations of all access control devices.
- d) Admin OPS IT determines the feasibility of equipment location and advises on the needs related to equipment.
- e) DPS is responsible for monitoring and responding to all university access control issues.
- f) Admin Ops IT is responsible for the maintenance of the main servers and access control data.
- g) Admin Ops IT determines the standards for all server-related hardware and software, including university-wide system upgrades.
- h) Admin Ops IT review all phases of the access control documentation for compliance with device locations and standard equipment.

### 3.Information Technology Services (ITS)

- a) ITS is the university department responsible for the installation and maintenance of all networks.
- b) ITS is responsible for providing network connectivity to the building and access control devices, as well as the maintenance of this connectivity.
- c) ITS determines the standards for all networks and network devices.
- d) ITS reviews all phases of the access control documentation for compliance with network and network device standards.

## USC BASIS OF DESIGN

- e) ITS makes recommendations if a building network needs to be upgraded.
- 4.USCard Services (USCard)
- a) USCard is the university department whose mission is to facilitate identity for fast, reliable, secure, convenient access to university-provided products and services.
  - b) USCard is responsible for maintaining the credentialing database and time schedules for existing buildings, on a building-by-building basis.
- G.Coordination with Project Consultants
- 1.Architects
- a) The Architect is responsible for providing all architectural backgrounds related to the project to the Security Consultants.
  - b) Access control, intrusion detection, and CCTV system design includes specific access control equipment as well as door hardware and locations of all equipment.
  - c) Coordination between the Security Consultant and the Architect should occur early and often during the project.
  - d) The Door Hardware Consultant will specify hardware that must be included in the door hardware schedule and must be coordinated with the Security Consultant.
  - e) Architectural drawings should account for space required by the access control equipment, including dedicated electrical rooms.
  - f) Locations of equipment may also need to be coordinated to maintain the architectural integrity of the building while meeting the security system needs.
- 2.Electrical Engineers
- a) Access control system design includes conduit and wiring (some low voltage, some line voltage) that must be included on the electrical drawings.
  - b) Coordination between the Security Consultant and the Electrical Engineer should occur early in the project and after every drawing issue.
  - c) The Electrical Engineer will provide quantities of conduit, the required size of conduit, and quantities of wire runs, as well as quantity and locations of equipment that must be included on the electrical drawings.
  - d) Electrical drawings should show all conduits, floor and wall penetrations, and power needs of the access control system.
  - e) Access control equipment is typically located in the electrical rooms.
  - f) The access control equipment needs to be considered during room layout and space planning.
- H.Coordination with Project Trades
- 1.General Contractors
- a) The General Contractor is responsible for coordinating all on-site work of the Security Integrator.
  - b) "Security Systems" installation should be scheduled along with all other trades for a project.
- 2.Electrical Contractors
- a) The Electrical Contractor is responsible for the installation of all conduits and power related to the access control system.
  - b) If these requirements are not coordinated on the electrical drawings, the Electrical Contractor is responsible for the conduits and power requirements shown on the security drawings.
  - c) The Security Integrator shall be a sub-contractor to the Electrical Contractor.
  - d) The Electrical Contractor is responsible to provide a full and complete access control system since the Security Integrator is sub-contracted to them.

## USC BASIS OF DESIGN

### 2.PROCEDURAL REQUIREMENTS

#### A.Drawings and Specifications

- 1.Regardless of the size and scope of the project, drawings and specifications shall be included and followed.
- 2.For smaller projects, PDF markups and sheet specs are acceptable.
- 3.For larger projects, full CAD drawings and either sheet or book specs are required.
- 4.All drawings shall be labeled 'EY'
- 5.Sheets shall be numbered following the university's standard numbering. Refer to the USC General Standards Guidelines Section 2 for appropriate series numbers.

#### B.Submittals

- 1.As the specifications indicate, all projects, regardless of the size and scope, shall include submittals of all devices and wiring included on the project. Submittals shall be provided to the Project Manager and/or General Contractor for tracking and approval.
- 2.No wiring or devices shall be installed prior to written approval of a submittal.

#### C.As-built Record Drawings

- 1.As the specifications indicate, all projects, regardless of the size and scope, shall include requirements for as-built record drawings at the end of each project.
- 2.For smaller projects, PDF red-lines may be accepted per approval from USC FPM.
- 3.For large projects, only editable CAD as-builts will be accepted. PDFs shall be provided in addition.

#### D.Close Out Documents

- 1.Closeout documents should include all equipment manuals and information provided by the manufacturer.
- 2.Documentation shall also include electronic versions of the panel schedules and wire diagrams as described herein.
- 3.Updated Design Documents
  - a) As part of the closeout document package, the Security Integrator must include an as-built version of the design documents.
  - b) These updated documents will include, but are not limited to:
    - 1) Door Schedules
    - 2) Floor Plans
    - 3) Door Details
    - 4) Camera Details
    - 5) Equipment Cabinet Details
    - 6) Door Wiring Schematics
    - 7) Single Line Diagrams
  - c) Documentation shall include any changes made in the field to the system as shown in the construction drawings and shall include conduit and wire runs for future reference.
  - d) Documents shall be provided in both PDF and CAD formats. CAD files shall not be PDF files referenced into a .dwg file. CAD files shall be properly referenced and shall include the color plot table.

#### E.Additional Project Documents

- 1.Additionally, documentation shall be provided by the Security Integrator related to the STC and the wiring of the project. These documents include:
  - 1) USC Lenel System Excel Sheet
  - 2) STC Cabinet Configuration
  - 3) STC Functional Diagram
  - 4) STC Panel Wiring Diagram
- 2.Documentation shall include all information specifically related to the installed system.

## USC BASIS OF DESIGN

3. Documents shall be provided in both PDF and CAD formats. CAD files shall not be PDF files referenced into a .dwg file. CAD files shall be properly referenced and shall include the color plot table.
4. The USC Lenel System Excel Sheet shall be provided in electronic form.
5. See Section 6, Exhibit D for document examples.
6. Add series number to notes section. Installer to date when the battery was installed. When replacing battery on the controller(s), ensure date is labeled.

### 3. Product Requirements

#### A. UL Requirements

1. All devices shall meet the City of Los Angeles' requirements for listing and labeling, including but not limited to UL listing and labeling.
2. All access control hardware must be approved by FPM lockshop.
3. All cameras and intrusion system devices must be approved by Admin OPS IT.
4. For devices and assemblies with proper UL listing and labeling, stickers shall be accessible and visible to the Inspectors.
5. Paperwork shall also be available during inspections and shall be provided to the university as part of the closeout documentation.
6. For devices and assemblies without proper UL listing and labeling, the project shall coordinate the testing of these devices and/or assemblies prior to inspection. Documentation shall be provided to the university as part of the closeout documentation.

#### B. Standard Lenel Equipment

1. See 28 1300 Access Control for requirements.

#### C. Standard Portal Entry Devices

1. The standard reader will be a multi-technology, contactless reader.
2. See 28 1300 Access Control for acceptable device list.
3. Magstripe readers are only acceptable on the University Park Campus and only with prior FPM and DPS approval.

#### D. Standard Intercom Devices

1. Intercoms shall be 2N-IP-Verso.
  - a) See 28 1300 Access Control for device requirements.

#### E. Standard Emergency Assistance Station Devices

1. Emergency Telephones shall be Talk-a-Phone ETP-MTE-72-Eco Tower, with ETP-MTE-WP-ARM mounting arm, and an ETP-500C emergency communications faceplate. Emergency Telephones shall have an overlooking CCTV camera at each location. Consult with project consultant or Admin Ops IT for model type.
  - a) See 28 1300 Access Control for device requirements.

#### F. Standard Request to Exit (REX) Devices

1. For New and Existing Buildings
  - a) For new and existing buildings, request to exit devices shall be included in the exit device hardware for all secured doors on the Lenel system.

#### G. Standard Electrified Hardware

1. For New and Existing Buildings (Refer to Div 8)
  - a) In general, mortise locks and exit devices are acceptable for new buildings. Electrified hinge at mortise lock or a continuous hinge with EPT is specified depending on the type of door and door devices.
  - b) If devices do not meet the standards, consult with FPM for approval.

#### H. Security Terminal Cabinets

1. STCs shall be comprised of the Life Safety Panel, pre-wired enclosure.
2. STC size shall be coordinated on a project-by-project basis, depending on the quantity of access control devices the project will utilize.

## USC BASIS OF DESIGN

3. STCs must be lockable. The lock/key type shall follow USC standards for these types of enclosures.
4. STCs shall be located in electrical rooms. STCs may be located in telecom rooms or IDF rooms as determined by Facilities Planning Management (FPM) and Information Technology Services (ITS) on a project basis.
5. Locations shall be coordinated ahead of time. Rooms such as janitor's closets and hidden or concealed rooms are not acceptable locations.

### I. Standard Schlage Devices

#### 1. Schlage AD400 Online System – Components

- a) Door Hardware: (Responsibility is part of Division 08)
  - i) AD lock exit devices will require an additional cable for the REX to function properly.
  - ii) AD Lock double door installations must be approved and reviewed by Lock Shop for engineering.
    - 1) Mortise Lock - AD400-MS-70-MT-TLR-XXX-JDCO6-4B
    - 2) Cylindrical Lock - AD400-CY-70-MT-TLR-XXX-JDCO6-4B
    - 3) Exit Device Trim - AD400-993R-70-MT-TLR-XXX-JDCO6-4B
    - 4) Panic Bar Request to exit – RX Plug 23536774
- b) Panel Interface Module (PIM)
  - 1) PIM400-1501
    - i) Each PIM can handle a maximum of (8) Schlage AD400 devices.
    - ii) Quantity and locations of PIM determined by performing a range test for connectivity by the Security Integrator.
    - iii) Range test report to be shared with FPM project manager on range test results.
    - iv) Range test may require additional change orders if preliminary range test is not adequate for final installation.
    - v) For all PIM installations, a PIM Antenna shall be utilized to maximize range capabilities.
    - vi) PIMs shall be located in electrical rooms. PIMs may be located in telecom rooms or IDF rooms as determined by Facilities Planning Management (FPM) and Information Technology Services (ITS) on a project-by-project basis.
- c) PIM Antenna
  - 1) PIM Antennas ANT-400-REM
  - 2) Indoor Omni Directional - SCHLAGE ANT400-REM-CEILING
  - 3) Indoor Bi-Directional - SCHLAGE ANT400-REM-HALL
  - 4) Indoor/Outdoor Omni Directional - SCHLAGE ANT400-REM-I/O
  - 5) Indoor/Outdoor Extended Range - SCHLAGE ANT400-REM-I/O+6dB
  - 6) MGB+MCA5 Grounding Kit required for outdoor applications
- d) Cable: University standard network cable
  - 1) Each PIM requires two network drops, one for communication and one for programming.
  - 2) For projects utilizing multiple PIMs within the same building, only one additional drop will be required.

#### 2. Schlage AD400 Online System – Requirements

- a) Any deviations to PIM locations must be approved prior to installation.
- b) Cannot be used for building perimeter doors.

### J. Standard Video Devices

1. See 28 2300 Video Surveillance for component requirements.

#### 2. Client Workstation

- a) Genetec Security Desk software allows for monitoring, surveillance, and review capabilities and functionality at the client workstations.

## USC BASIS OF DESIGN

- b) Security Desk software shall be provided on all projects where needed.
- c) Additionally, some projects may include the physical workstation in the specifications if an existing workstation is not available.

### K. Emergency Phones

- 1. Refer to 28 1300 Access Control for requirements

### L. Wire Requirements

- 1. Standard Composite Cable for Reader, Door contacts, REX, and Power (White Sheathing)

#### a) Description

- 1) The standard composite 'L' cable acceptable for use with the card readers, door contacts, request to exit devices (REX), and power includes:
  - i) (1) - 18 AWG, 4 conductors PVC/PVC unshielded - Grey jacket
  - ii) (1) - 22 AWG, 4 conductors PVC/PVC unshielded - Blue jacket
  - iii) (1) - 22 AWG, 4 conductors PVC/PVC unshielded - White jacket
  - iv) (1) - 22 AWG, 6 conductors PVC/PVC shielded - Orange jacket

#### b) Manufacturers and Model Numbers

- 1) Connect Air WSECCOMP-2835
- 2) Arrow Wire & Cable ACP-3NS-1SH-9MR
- 3) All Star Cable C228184
- 4) Windy City Wire 416400 WBT (Direct Burial for underground use)

#### c) Requirements

- 1) For each single access control door, provide one standard composite 'L' cable.
- 2) For each single access control door with more than one reader, provide one standard composite 'L' cable plus one 22 AWG, 6 conductors PVC/PVC shielded with Orange jacket single cable per reader.
- 3) For each single access control door with at least one reader and an auto operator, provide two standard composite 'L' cables.
- 4) For each double access control door, provide two standard composite 'L' cables.
- 5) End-of-line resistors are required for all field devices monitored by the access control system.

#### d) Termination Colors

<u>Device</u>	<u>Jacket Color</u>	<u>Size</u>	<u>Conductors to Use</u>	<u>Spare Conductors</u>
Card Reader (CR)	Orange	22/6	Red, Black, White, Green, Brown	Orange
Lock (LK)	Gray	18/4	Red, Black	White, Green
Request to Exit (REX)	Blue	22/4	White, Green	Red, Black
Door Contact (DC)	White	22/4	Red, Black	White, Green

### 2. Cable Acceptable for Cameras

- a) See 28 2300 Video Surveillance for component requirements
- b) Existing cabling is CAT5e. New cabling is CAT6a.

## USC BASIS OF DESIGN

- c) Consult with ITS on current camera cabling requirements.
- M.Power Requirements
- 1.Emergency Power
    - a) Where available, access control devices shall be provided optional standby power from a generator.
    - b) Battery back-up shall always be included.
    - c) Dedicated circuit for each power supply.
  - 2.Power for Electric Unlocking on Exit Devices
    - a) Power for electric unlocking on exit devices shall be comprised of the Command Access PS480B (provided as part of Division 08)
    - b) To be mounted at the Life Safety Access Control Panel location, not exceeding the manufacturers recommended wiring distance.
    - c) Provide minimum one (1) PS480B per ACP location.
    - d) Not to exceed 75% capacity of one (1) PS480B. Provide additional as needed per project.
    - e) Limit six (6) doors per PS480B.
    - f) Provide one circuit per ACP location to PS480B.
    - g) Any deviations will need to be approved by FPM.
  - 3.Power for All Locks
    - a) All locks shall be provided with 24 volts.
  - 4.Power for Access Control System Boards
    - a) All boards shall be provided with 12 volts.
- N.Specialty Areas
- 1.Elevators
    - a) Elevators are not required to be controlled as part of the access control system.
    - b) All elevators must be equipped with floor tracking, even if this feature is not enabled.
    - c) Open Floor Access
      - 1) For Open Floor Access, an authorized card is required to access exterior elevators after hours.
      - 2) Once access is granted, the elevator may proceed to any floor without restriction.
      - 3) Card Reader: See 23 13 00 for acceptable card reader devices
      - 4) Wiring for Card Reader – Orange 22/6 shielded single cable from Lenel 1320 board to elevator card reader.
      - 5) Shunt to Elevator Control – 18/2 unshielded (no specific color) single cable from STC to elevator control panel or elevator control (in elevator control room). May also go to push button depending on elevator design.
      - 6) Lenel Board: (1) dedicated LNL-1320 board per elevator cab.
    - d) Controlled Floor Access
      - 1) For Controlled Floor Access, an authorized card is required to access exterior elevators and to gain access to each floor. The elevator will only proceed to the floor which access is granted to.
      - 2) Card Reader: See 23 13 00 for acceptable card reader devices.
      - 3) Wiring for Card Reader – Orange 22/6 shielded single cable from Lenel 1320 board to elevator card reader.
      - 4) Lenel Board: LNL-1320
      - 5) Wiring for Controlled Floor Access buttons – Provide (1) 18/4 unshielded (no color preference) single cable for each floor to be controlled.
      - 6) Quantity of LNL-1320 boards will be determined by project requirements.
    - e) Elevator Coordination
      - 1) Coordination is required between the Security Consultant, the Architect, and the elevator vendor related to elevator design and functionality.



## USC BASIS OF DESIGN

- 2) For New Construction – the Security Consultant and Security Integrator are responsible for the Lenel boards, readers, wire, and programming related to the type of floor access desired. The elevator specifications shall call out for provisions for “future” card readers.
  - 3) For Existing Buildings – the Security Consultant and Security Integrator are responsible for the Lenel boards, readers, wire, and programming related to the type of floor access desired. The elevator specifications shall call out to be modified for relays and connections.
2. Roll Up Doors, Elephant Doors, Large Sliding Doors
- a) External door contacts
    - 1) Wiring – 22/4 unshielded white single cable per contact
    - 2) Lenel Board – LNL-1320
    - 3) Maximum 2 doors per LNL-1320
    - 4) External doors should be landed to the reader port regardless if a reader is used.
  - b) For installations with several (4+) roll up, elephant, or large sliding doors, it is acceptable to substitute an LNL-1100 board instead of the LNL-1320. Consult with FPM for approval.
  - c) The Security Integrator is responsible for the door contacts, boards, wire, and programming related to these doors.
  - d) The door vendor and door hardware contractor should be involved in the appropriate manner required to maintain warranty on the door and lock.
  - e) Doors can work on a time schedule or with an override keypad. If an override keypad is provided, programming of the keypad becomes the responsibility of the Security Integrator.
3. Parking Lots (including Gates or Arms)
- a) Card Reader: See 23 13 00 for acceptable card reader devices
  - b) Wiring for Card Reader – USC standard composite cable – Orange from reader to LNL-1320 board.
  - c) Lenel Board: LNL-1320
  - d) Pedestal: Consult FPM per project.
  - e) Output from relay at STC to gate motor: USC standard composite cable – Grey from relay to LNL-1320 board.
  - f) Gate Release Button – location determined by project somewhere inside a building/facility to open the gate/arm.
  - g) Wire: 22/4 white single cable from release button location to LNL-1320 board.
  - h) 2N Intercom – location determined by project needs.

## 4. Installation Design Requirements

### A. Labeling

#### 1. Security Terminal Cabinets

- a) All Security Terminal Cabinets (STC) shall have panel schedules and wiring diagrams included within the enclosure. 8” x 11 documents are to be provided in a plastic sleeve permanently mounted to the inside of the STC door.
- b) All Security Terminal Cabinets (STC) and Power Supplies shall have laminated three-layer plastic with engraved black letters on white background color. Minimum thickness shall be 1/8”. Letter size shall be 1/2” minimum.
- c) STC and Power Supply Labeling shall be in accordance with the installation details provided within the project design.
- d) Refer to Division 28 specifications Section 28 05 53

#### 2. Door Openings

## USC BASIS OF DESIGN

- a) For all other doors controlled or monitored by Lenel, provide a P-touch label with door name (as named in Lenel program) on the top of the door edge on the hinge side.
- b) P-touch label shall be black lettering on white ¼" tape

### 3. Lenel Panel Relays

- a) All relays on Lenel panel boards shall be labeled with a P-touch label.
- b) Doors shall be identified with USC door numbers, not architectural door numbers.
- c) P-touch label shall be black lettering on white ¼" tape

## B. Installation standards by opening type

### 1. Entrances with Card Readers

- a) General Location
  - 1) Entrances with Card Readers are designated as the main location for access to a building when secured.
  - 2) Typically, these doors are specified near a parking area or walkway for ease of accessibility.
  - 3) These doors may also be specified close to elevators and ADA accessible entrances.
  - 4) At least one entrance location is required to have a card reader on the exterior of a building.
  - 5) For the interior, this location would be the main entrance location to a secure space.
  - 6) All readers must be installed in conjunction with the City of Los Angeles and ADA standards.
- b) Equipment
  - 1) An Entrance with Card Reader is equipped, at minimum, an integrated request to exit (REX) device, electrified hardware, a door contact per leaf, and with one card reader per opening.
- c) Doors and Hardware – refer to Div 8 for current door hardware specs and consult with FPM Lockshop
  - 1) Exterior - Single Door - With Mortise Lock
    - i) Request to exit (REX) device shall be integrated to the mortise lock and shall be fail secure.
    - ii) A power transfer hinge is required
    - iii) Cylindrical locks, electric strikes, and door loops are not acceptable.
  - 2) Exterior - Single Door - With Exit Device
    - i) Request to exit (REX) device shall be integrated to the exit device and shall include electric latch retraction.
    - ii) EPT or PT5 power transfer is required.
    - iii) Electric strikes and door loops are not acceptable.
  - 3) Exterior – Pair of Doors - With Mortise Lock
    - i) Request to exit (REX) device shall be integrated to the mortise lock and shall fail secure.
    - ii) Door contact shall be provided on inactive leaf.
    - iii) A power transfer hinge is required.
    - iv) Cylindrical locks, electric strikes, and door loops are not acceptable.
  - 4) Exterior – Pair of Doors -With Exit Device – Rim Devices with Mullion
    - i) Request to exit (REX) device shall be integrated to the exit device.
    - ii) EPT or PT5 power transfer is required.
    - iii) Electric strikes and door loops are not acceptable.
  - 5) Exterior – Pair of Doors -With Exit Device – Concealed Vertical Rod
    - i) Specifications shall include top and bottom latching, and the request to exit (REX) device shall be integrated to the exit device.

## USC BASIS OF DESIGN

- ii) EPT or PT5 power transfer is required.
  - iii) Less bottom rod, electric strikes, surface vertical rods, and door loops are not acceptable.
- 6) Interior – Single Door - With Mortise Lock
- i) Request to exit (REX) device shall be specified in the mortise lock.
  - ii) A power transfer hinge is required.
  - iii) Electric strikes and door loops are not acceptable.
- 7) Interior – Single Door - With Exit Device
- i) Request to exit (REX) device integrated to the exit device and shall include electric latch.
  - ii) EPT or PT5 power transfer is required.
  - iii) Electric strikes and door loops are not acceptable.
- 8) Interior – Single Door – Stairwells & Fire Rated Doors
- i) Request to exit (REX) device shall be integrated to the exit device and shall include electric trim.
  - ii) Stairwell door must be fail-safe, and be tied into the fire alarm system.
  - iii) EPT or PT5 power transfer is required.
  - iv) Latch retraction, electric strikes, and door loops are not acceptable
- 9) Interior – Pair of Doors- With Mortise Lock
- i) Request to exit (REX) device shall be integrated to the mortise lock.
  - ii) A power transfer hinge is required.
  - iii) Electric strikes and door loops are not acceptable.
- 10) Interior – Pair of Doors- With Cylindrical Lock
- i) Request to exit (REX) device shall be integrated to the cylindrical lock.
  - ii) A power transfer hinge is required.
  - iii) Electric strikes are not acceptable.
- 11) Interior – Pair of Doors - With Exit Device – Concealed Vertical Rod
- i) Request to exit (REX) device shall be integrated to the exit device. Less bottom rods are acceptable.
  - ii) EPT or PT5 power transfer is required.
  - iii) Electric strikes and surface vertical rods are not acceptable.
- d) Wire Requirements
- 13) Entrances with a Card Reader must be provided with the university standard composite cable.
- 14) Conduit
- i) Conduit is not required for inside the door frame as the university-approved composite cable is plenum rated. Cable shall be routed to the device locations – card reader, door contact, and power transfer hinge.
  - ii) A 12x12x6 junction box (j-box) is required for all door installations. The J-box shall be installed in the ceiling above the door for wire access.
  - iii) Single door installations may use a 6x6x6 j-box, with Lock Shop approval. The J-box shall be installed in the ceiling above the door for wire access.
  - iv) Conduit may be necessary from the junction box back to the location of the Lenel panel based on the type of ceiling in the building.
  - v) All home run conduit installations from ACP to J-Box shall be 1" minimum.
  - vi) All other conduit installations shall be ¾" minimum.
- 15) Color Scheme
- i) The following color schedule shall be used:

## USC BASIS OF DESIGN

Device	Jacket Color	Size	Conductors to Use	Spare Conductors
Card Reader (CR)	Orange	22/6	Red, Black, White, Green, Brown	Orange
Lock (LK)	Gray	18/4	Red, Black	White, Green
Request to Exit (REX)	Blue	22/4	White, Green	Red, Black
Door Contact (DC)	White	22/4	Red, Black	White, Green

### 2. Normal Operations Entrances

#### a) General Location

- 1) Normal Operations Entrances are designated as any door that can be accessed during normal business hours but is not useable for entrance during off-hours.
- 2) Normal Operations Entrances can be electronically unlocked during business hours for entrance but can always be used as an exit.
- 3) Normal Operations Entrances would consist of the group of doors without card readers and those not designated as Exit Only Entrances.

#### b) Equipment

- 1) A Normal Operations Entrance is equipped, at minimum, with a request to exit (REX) device, a door contact, and electrified hardware.

#### c) Doors and Hardware

- 1) Exterior - Single Door - With Mortise Lock
  - i) Request to exit (REX) device shall be integrated to the mortise lock and shall fail secure.
  - ii) A power transfer hinge is required.
  - iii) Cylindrical locks, electric strikes, and door loops are not acceptable.
- 2) Exterior - Single Door - With Exit Device
  - i) Request to exit (REX) device shall be integrated to the exit device and shall include electric latch retraction.
  - ii) EPT or PT5 power transfer is required.
  - iii) Electric strikes and door loops are not acceptable.
- 3) Exterior – Pair of Doors - With Mortise Lock
  - i) Request to exit (REX) device shall be integrated to the Mortise lock and shall fail secure.
  - ii) A power transfer hinge is required.
  - iii) Cylindrical locks, electric strikes, and door loops are not acceptable.
- 4) Exterior – Pair of Doors - With Exit Device – Rim Devices with Mullion
  - i) Request to exit (REX) device integrated to the exit device.
  - ii) EPT or PT5 power transfer is required.
  - iii) Electric strikes and door loops are not acceptable.
- 5) Exterior – Pair of Doors – With Exit Device – Concealed Vertical Rod
  - i) Specifications shall include top and bottom latching, and the request to exit (REX) device shall be integrated to the exit device.
  - ii) EPT or PT5 power transfer is required.

## USC BASIS OF DESIGN

- iii) Less bottom rod, electric strikes, surface vertical rods, and door loops are not acceptable.
- 6) Interior – Single Door - With Mortise Lock
  - i) Request to exit (REX) device shall be integrated to the mortise lock.
  - ii) A power transfer is required.
  - iii) Electric strikes and door loops are not acceptable.
- 7) Interior – Single Door - With Exit Device
  - i) Request to exit (REX) device shall be integrated to the exit device and shall include electric latch retraction or electrified trim.
  - ii) EPT or PT5 power transfer is required.
  - iii) Electric strikes and door loops are not acceptable.
- 8) Interior – Single Door – Stairwells & Fire Rated Doors
  - i) Request to exit (REX) device shall be integrated to the exit device and shall include electric trim.
  - ii) Stairwell doors must be fail-safe, and be tied into the fire alarm system.
  - iii) EPT or PT5 power transfer is required.
  - iv) Latch retraction, electric strikes, and door loops are not acceptable
- 9) Interior – Pair of Doors - With Mortise Lock
  - i) Request to exit (REX) device shall be integrated to the mortise lock.
  - ii) A power transfer hinge is required.
  - iii) Electric strikes and door loops are not acceptable.
- 10) Interior – Pair of Doors - With Cylindrical Lock
  - i) Request to exit (REX) device shall be integrated to the cylindrical lock.
  - ii) A power transfer hinge is required.
  - iii) Electric strikes are not acceptable.
- 11) Interior – Pair of Doors - With Exit Device – Concealed Vertical Rod
  - i) Request to exit (REX) device shall be integrated to the exit device.
  - ii) Less bottom rods are acceptable.
  - iii) EPT or PT5 power transfer is required.
  - iv) Electric strikes and surface vertical rods are not acceptable.
- 12) Wire Requirements
  - i) Normal Operations Entrances should be provided with the university standard composite cable.
- 13) Conduit
  - i) Conduit is not required for inside the door frame as the university-approved composite cable is plenum rated. Cable shall be routed to the device locations – card reader, door contact, and power transfer hinge.
  - ii) A 12x12x6 junction box (j-box) is required for all door installations. The J-box shall be installed in the ceiling above the door for wire access.
  - iii) Single door installations may use a 6x6x6 j-box, with Lock Shop approval. The J-box shall be installed in the ceiling above the door for wire access.
  - iv) Conduit may be necessary from the junction box back to the location of the Lenel panel based on the type of ceiling in the building.
  - v) All home run conduit installations from ACP to J-Box shall be 1" minimum.
  - vi) All other conduit installations shall be ¾" minimum.
- 14) Color Scheme
  - i) The following color schedule shall be used:

## USC BASIS OF DESIGN

<u>Device</u>	<u>Jacket Color</u>	<u>Size</u>	<u>Conductors to Use</u>	<u>Spare Conductors</u>
Card Reader (CR)	Orange	22/6	Red, Black, White, Green, Brown	Orange
Lock (LK)	Gray	18/4	Red, Black	White, Green
Request to Exit (REX)	Blue	22/4	White, Green	Red, Black
Door Contact (DC)	White	22/4	Red, Black	White, Green

### 1. Exit Only Doors

#### a) General Location

- 1) Exit Only Doors are designated as any door that can be used only as a means of egress regardless of the time of day.
- 2) Exit Only Doors do not have door hardware or keyways to be able to be entered from the outside.
- 3) Exit Only Doors are typically designated only on the outside of a building.
- 4) Examples of Exit Only Doors include exits from stairwells and large auditoriums.

#### b) Equipment

- 1) A door indicated as an Exit Only Entrance is equipped, at minimum, with door contacts, power transfer hinge, and integrated request to exit (REX) device.

#### c) Doors and Hardware

- 1) Exterior - Single Door - With Mortise Lock
  - i) Request to exit (REX) device shall be integrated to the mortise lock.
  - ii) A power transfer hinge is required.
  - iii) Cylindrical locks and door loops are not acceptable.
- 2) Exterior - Single Door - With Exit Device
  - i) Request to exit (REX) device shall be integrated to the exit device.
  - ii) EPT or PT5 power transfer is required.
  - iii) Door loops are not acceptable.
- 3) Exterior – Pair of Doors - With Mortise Lock
  - i) Request to exit (REX) device shall be integrated to the mortise lock.
  - ii) A power transfer is required.
  - iii) Cylindrical locks and door loops are not acceptable.
- 4) Exterior – Pair of Doors - With Exit Device – Rim Devices with Mullion
  - i) Request to exit (REX) device shall be integrated to the exit device.
  - ii) EPT or PT5 power transfer is required.
  - iii) Electric strikes and door loops are not acceptable.
- 5) Exterior – Pair of Doors - With Exit Device – Concealed Vertical Rod

## USC BASIS OF DESIGN

- i) Specifications shall include top and bottom latching, and the request to exit (REX) device shall be integrated to the exit device.
  - ii) A power transfer hinge is required.
  - iii) Less bottom rods, surface vertical rods, and door loops are not acceptable.
- 6) Interior – Single Door - With Mortise Lock
- i) Request to exit (REX) device shall be integrated to the mortise lock.
  - ii) A power transfer hinge is required.
  - iii) Door loops are not acceptable.
- 7) Interior – Single Door - With Exit Device
- i) Request to exit (REX) device shall be integrated to the exit device.
  - ii) EPT or PT5 power transfer is required.
  - iii) Door loops are not acceptable.
- 8) Interior – Pair of Doors - With Mortise Lock
- i) Request to exit (REX) device shall be integrated to the mortise lock.
  - ii) A power transfer hinge is required.
  - iii) Door loops are not acceptable.
- 9) Interior – Pair of Doors - With Cylindrical Lock
- i) Request to exit (REX) device shall be integrated to the cylindrical lock.
  - ii) A power transfer hinge is required.
- 10) Interior – Pair of Doors - With Exit Device – Concealed Vertical Rod
- i) Request to exit (REX) device shall be integrated to the exit device.
  - ii) Less bottom rods are acceptable.
  - iii) EPT or PT5 power transfer is required.
  - iv) Surface vertical rods are not acceptable.
- 11) Wire Requirements
- i) Exit Only Entrances should be provided with the university standard composite cable.
  - ii) Optionally, individual wires for the devices required at the door can be specified, but the color scheme must be adhered to.
- 12) Conduit
- i) Conduit is not required for inside the door frame as the university-approved composite cable is plenum rated. Cable shall be routed to the device locations – card reader, door contact, and power transfer hinge.
  - ii) A 12x12x6 junction box (j-box) is required for all door installations. The J-box shall be installed in the ceiling above the door for wire access.
  - iii) Single door installations may use a 6x6x6 j-box, with Lock Shop approval. The J-box shall be installed in the ceiling above the door for wire access.
  - iv) Conduit may be necessary from the junction box back to the location of the Lenel panel based on the type of ceiling in the building.

## USC BASIS OF DESIGN

- v) All home run conduit installations from ACP to J-Box shall be 1" minimum.
- vi) All other conduit installations shall be 3/4" minimum.

### 13) Color Scheme

- i) The following color schedule shall be used:

<u>Device</u>	<u>Jacket Color</u>	<u>Size</u>	<u>Conductors to Use</u>	<u>Spare Conductors</u>
Card Reader (CR)	Orange	22/6	Red, Black, White, Green, Brown	Orange
Lock (LK)	Gray	18/4	Red, Black	White, Green
Request to Exit (REX)	Blue	22/4	White, Green	Red, Black
Door Contact (DC)	White	22/4	Red, Black	White, Green

### C. Installation Guidelines

#### 1. Coordination

- a) Access control wire installation needs to be coordinated with the project schedule.
- b) On any project where door frames are being replaced, regardless if a new building or an existing building, wiring for access control shall be installed into the frame before the frame is mounted and sealed.
- c) The Project Manager and General Contractor shall be responsible for coordinating with the Security Integrator.

#### 2. Electrical Connections to Door Hardware

- a) Connections to door hardware shall be made using provided quick-connects or solder
- b) Wire nuts and splices are not acceptable.

### D. Programming

1. The Security Integrator is responsible for programming to ensure a complete working system and integration between the existing Lenel system and the new components.
2. Programming rights are provided by Admin OPS IT on a project-by-project basis.
3. The maximum amount of users programmed by the Security Integrator is 50. Anything over 50 will require additional hours on the project that need to be included in the change order. These users must be transmitted in a single document at a single time.
4. Requests for programming rights should be made in writing to the Project Manager at least 2 days prior to the need.
5. The Project Manager shall make all arrangements with Admin OPS IT to have access available.

### E. Device Naming and Coordination

1. Each device and door shall have a name consistent with USC naming standards.
2. Once the design is complete and all equipment has been coordinated, Admin OPS IT will use the construction documents to create names.
3. USC Responsibility
  - a) Admin OPS IT will provide the Access Control Equipment Template in an Excel electronic version.
  - b) Information that will be completed by Admin OPS IT includes:



## USC BASIS OF DESIGN

- c) Refer to the attached programming sheet.
- 4. Security Integrator Responsibility
  - a) The contractor is required to complete the remaining fields of the attached programming sheet template in Excel, including:
    - 1) List out the remaining fields from the programming sheet attached above. Send the completed programming sheet to FPM Lockshop and Admin OPS IT.
  - b) The attached programming sheet file shall be provided as part of the closeout documentation.
  - c) The Security Integrator must notify Admin OPS IT when a new card reader is added to the system.
  - d) See Section 6, Exhibit A, for example of forms.
- F. Time Schedule Set Up
  - 1. The Security Integrator shall set up a default time schedule as part of the initial system programming for exterior doors.
  - 2. The general schedule will have the doors open from 7am to 7pm.
  - 3. Alternate schedules shall be coordinated between DPS, the Security Integrator, the building occupants, and the Project Manager.
- G. Credentialing Database Management
  - 1. For Existing Facilities
    - a) USCard Services (USCard) manages and maintains the credentialing system for new and existing Lenel systems.
  - 2. For New Buildings and/or New Lenel Systems
    - a) The Security Integrator is responsible as part of the installation package for programming the initial credentialing database for a new Lenel system or new building up to a maximum of 50 cardholders which must be transmitted in a single document.
    - b) The Project Manager is responsible for coordinating the needs of the building occupants with the Security Integrator to set up the initial credentialing database.
    - c) Once the credentialing database is set up, the building occupants can use Area Access Manager software to maintain the database or contract through USCard.
- H. Area Access Manager
  - 1. Option for when a department wants to control access to their specific area.
  - 2. Building based
  - 3. Lenel OnGuard Area Access Manager (AAM) allows for the performance of the following functions:
    - a) Assigning access levels to cardholders
    - b) Removing access level assignments from cardholders
    - c) Generating reports to determine who has access to a particular area
  - 4. Software is provided as part of the implementation and training by Admin OPS IT.
  - 5. Security Consultant and Project Manager are responsible for discussing the needs for this software with the users
- I. Lenel Licensing
  - 1. A license is required to be held by the university for the Lenel system, including users and card readers.
  - 2. One license is required per device and must be maintained for the device to remain active.
  - 3. Card reader licenses are purchased in blocks of 64 from Lenel.
  - 4. Licenses are purchased by the project to cover the devices involved in the project.
  - 5. Any remaining licenses belong to the university for future use.
  - 6. For projects with (24) or more devices, an additional block of licenses shall be purchased and given to the university.

## USC BASIS OF DESIGN

### 5.Evaluation or Commissioning

#### J.Commissioning

- 1.All access control system installations must be pre-tested prior to commissioning.
- 2.Complete documentation of the pre-test shall be provided to USC for confirmation.
- 3.Once pre-testing is completed and approved, all access control system installations must be commissioned.
- 4.Commissioning includes the testing of a complete system – card readers, door contacts, REX devices, electrified locks, sounders, cabinet tamper switches, power fail switches, etc.
- 5.The commissioning process is included in the scope of work for both the Security Consultant and the Security Integrator.
- 6.A system is accepted as complete only after the commissioning process is complete.

#### K.Document Requirements

- 1.Follow the checklist outlined in the attached testing and commissioning document.

#### L.Training

- 1.All projects, regardless of the size, shall include training for both the O&M staff to maintain the equipment and the building occupants to use the system.
- 2.Training sessions may be attended by other university personnel as well.
- 3.The Security Integrator shall provide a written training plan including outline and time requirement as part of the project requirements.
- 4.The training plan shall be submitted to the General Contractor and/or Project Manager and shall be approved by the university.
- 5.Training shall occur prior to the final hand off of the system.
- 6.End User Training
- 7.All projects, regardless of the size, shall include training for the building occupants to use the system.
- 8.Training sessions may be attended by other university personnel as well.
- 9.The Security Integrator shall provide a written training plan including outline and time requirement as part of the project requirements.
- 10.The training plan shall be submitted to the General Contractor and/or Project Manager and shall be approved by the university.

**Training shall occur prior to final hand off of the system.**

# USC BASIS OF DESIGN

## Exhibits

### A. Forms

#### 1. Completing the Lenel System Excel Sheet

- a) As part of the installation of Lenel equipment at USC, the VAR is required to complete the Excel upload document.
- b) The file will be provided with the following fields pre-populated:
  - Equipment type
  - Keyword
  - Nomenclature
  - Description: this is to be used as the as the Name in Lenel.
  - Building
  - Equipment group
  - Status

#### 2. The VAR will complete the following fields for each item listed in the spreadsheet as applicable:

- MFR
- MODEL
- SERIAL\_NO
- MFR\_PART\_NO
- ACQUISITION\_DATE
- ACQUISITION\_VENDOR
- WARRANTY\_DATE
- WARRANTY\_DESCRIPTION
- WARRANTY\_VENDOR
- WARRANTY\_PO\_NUMBER
- EQUIPMENT

#### 3. The EQUIPMENT field is used to denote which panels, reader boards, and readers are related, and similarly, which NVR, convertor box, and cameras.

1. Top level items, such as ISCs and NVRs, should be numbered sequentially – 1,2,3, etc.
2. Converter boxes that belong to NVR 1 would be numbered 1A, 1B, 1C, etc.
3. Cameras belonging to convertor box 1A would be numbered 1A1, 1A2, 1A3, etc.
4. All numbers must be unique in the spreadsheet.
5. Example:

Description	Parent	Equipment
New NVR 1		1
Axis box 1	New NVR1	1A
Camera 1	Axis box 1	1A1
Camera2	Axis box 1	1A2
Axis box 2	New NVR1	1B
Camera 3	Axis box 2	1B1
Camera4	Axis box 2	1B2

## USC BASIS OF DESIGN

Example Excel Spreadsheet – fields

EQUIPMENT	EQUIP_TYPE	KEYWORD	NOMENCLATURE
VARCHAR2(15)	VARCHAR2(10)	VARCHAR2(10)	VARCHAR2(64)
	D5030*	SEC-AC-PNL	CONTROL PANEL, SECURITY ACCESS CARD
	D5030*	SEC-AC-RDR	READER, SECURITY ACCESS CARD
	D5030*	SEC-AC-CTL	CONTROL BOARD, SECURITY ACCESS CARD

DESCRIPTION	ASSET_NO	PARENT	SITE
LONG	VARCHAR2(15)	VARCHAR2(15)	VARCHAR2(10)
Lenel Access control Panel - PIC Building			
Lenel Access control Reader - ZNI Passenger Elevator Cab 2			
Lenel Reader Board Montgomery Ross Fisher (MOMS) Address 0			

ZONE	BUILDING	FLOOR	ROOM
VARCHAR2(10)	VARCHAR2(10)	VARCHAR2(10)	VARCHAR2(10)
	0020		
	2820		
	0410		

STATUS	EQUIP_GROUP	PM_GROUP	MFR
VARCHAR2(10)	VARCHAR2(15)	VARCHAR2(10)	VARCHAR2(10)
NOT MAINT	ACCESSCTRL		
NOT MAINT	ACCESSCTRL		
NOT MAINT	ACCESSCTRL		

MODEL	SERIAL_NO	MFR_PART_NO	ACQUISITION_DATE
VARCHAR2(25)	VARCHAR2(20)	VARCHAR2(30)	DATE

ACQUISITION_DESCRIPTION	ACQUISITION_VENDOR	WARRANTY_DATE	WARRANTY_DESCRIPTION
VARCHAR2(2000)	VARCHAR2(20)	DATE	VARCHAR2(2000)

WARRANTY_VENDOR	WARRANTY_PO_NUMBER	LENEL_ID
VARCHAR2(20)	VARCHAR2(15)	VARCHAR2(15)

## USC BASIS OF DESIGN

### Approved Consultant and Contractor List (Revised 04/2023)

#### 1. Approved Security Consultants

- Bogaard Group International, Inc. #129392-0  
959 Seward St. Suite 303, Los Angeles, CA 90038  
Contact: Matt Edgar (P) 951-520-7758 (E) [matt.edgar@bogaardgroup.com](mailto:matt.edgar@bogaardgroup.com)
- Exante360, Vendor #78014-0  
505 Avenida Lucia, Newport Beach, CA 92660  
Contact: George Honaker (P) 619-654-5761 (E) [ghonaker@exante360.com](mailto:ghonaker@exante360.com)
- TRC Solutions Inc, Vendor #29730-0  
17911 Von Karman Ave Suite 400, Irvine, CA 92614 Contact: Michael Mello  
(P) 949-377-8068 (E) [mmello@trccompanies.com](mailto:mmello@trccompanies.com)

#### Approved Security Integrators (in alphabetical order)

[Consult with FPM as to which contractors fit the requirements of each project]

- Converjint Technologies, Vendor # 28733-0  
607 N Poplar Street, Orange, CA 92868  
Contact: Justin Neuberger (P) 714-342-1565 (E) [justin.neuberger@converjint.com](mailto:justin.neuberger@converjint.com)

**END OF DOCUMENT**

# USC BASIS OF DESIGN

## 28 1300 ACCESS CONTROL

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
  - 1. For other related requirements, refer to Section 28 10 00 Design Requirements, Section 28 16 00 Intrusion Detection, and Section 28 23 00 Video Surveillance.
  - 2. For other related USC documents, refer to:
    - a) USC Division 28 Specifications
- B. The following table summarizes the types of particular requirements identified within this Section:

Requirements listed	Preferences Listed	Disallowed items listed	Items requiring commissioning/testing
Access control system devices and control equipment	Lenel Systems International	All other access control system devices and control equipment	Access control system devices and control equipment

- C. Integration with other systems:
  - 1. Work performed under separate Sections may connect to the work of Division 28 Sections for the purpose of auxiliary alarm monitoring. For example, a CO alarm in a Parking Structure may send primary alarm signals to a BMS or other Engineering system and send secondary alarm signals to the Access Control or Intrusion Detection systems for auxiliary alarm monitoring, notification, and response.
- D. Emergency Assistance Stations
  - 1. With reference to USC Division 27 Specification Section 27 32 26.
    - a) Emergency Assistance Stations shall be Talk-a-Phone ETP-MTE-72-Eco Tower, with ETP-MTE-WP-ARM mounting arm, and an ETP-500C emergency communications faceplate.
    - b) Emergency Assistance Stations shall have an overlooking Axis camera (CCTV) mounted at each location.
      - a) Consult with Security Consultant and Admin Ops IT for camera model specifics.
    - c) Refer to USC ITS color requirements for outdoor devices.
      - a) Preferred: Chilean Red
    - d) Emergency Telephone installation and placement on specific projects are subject to USC DPS approval.
  - 2. The trigger or threshold for providing Emergency Telephones on specific projects relates to the overall campus design intent for emergency communications. USC DPS wants people to be within the line-of-sight of an Emergency Telephone while on a normal path of traffic such as a sidewalk or pathway at any on-campus location outside of buildings. New construction projects typically block existing lines of sight or create more enclosed spaces than before.
  - 3. New construction projects should account for providing and installing four (4) new Emergency Telephones. This quantity may be reduced during the design phase approvals, but this will provide a placeholder standard allowance for project budget and cost estimating purposes.
  - 4. Emergency Telephones shall be programmed by the Security Integrator to dial

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- Dispatch. This number may be obtained from USC ITS.
5. Emergency Telephones shall not be programmed with the automatically recorded announcement of the calling location option. Instead, the Emergency Telephones shall have Caller ID activated for display on the existing DPS Computer-Aided Dispatch console. Coordinate with USC ITS.
  6. Note that while monitored telephones are required in elevators, these units are separate from the Emergency Telephones discussed herein and are not in the Security Integrator's scope of work.

### 2. PROCEDURAL REQUIREMENTS

#### A. Design considerations specific to components in this Section:

##### 1. Required:

- a) All requests for coordination between Division 28 and other entities shall be requested through the USC PM and FPM. For example, requests for USC or project design team review coordination and approval.
- b) All requests shall be in writing, and discussions and decisions shall be documented in writing, listing the USC or project design team members involved and the date.
- c) For any University Residential project, USC Housing needs to be involved in the decision-making and design approval process.
- d) For any University High-Rise project, USC DPS needs to be involved in the decision-making and design approval process. High-rise rooftops (at or above 4 stories) must be accessible in Los Angeles. Therefore, the rooftop doors shall be alarmed with both an audible local alarm sounder and an alarm contact door position switch. USC DPS Dispatch shall monitor alarm signals via the Lenel access control system (or Bosch alarm receiver where intrusion detection system is present). The alarming condition of the door shall be supported by highly visible signage at the alarmed rooftop doors. Rooftop access for roofs less than 4 stories may be locked.

### 3. SYSTEM REQUIREMENTS

#### A. Design considerations specific to components in this Section:

##### 1. Required:

- a) Every USC building must have at least one exterior door controlled by a card reader interfaced with the existing Lenel USC access control system. The building owner and/or designee shall administer and manage the users and access rights for this card reader.
- b) The access control system must control all exterior doors, whether monitored, electrically locked, or both.
- c) In terms of the access control system, exterior doors are designated as
  - a) 1. Emergency Exit Only
  - b) 2. Exit Only
  - c) 3. Entry/Exit Doors (or)
  - d) 4. Reader Controlled Entry/Exit Doors.
- d) Exit/Entry and Reader Controlled doors will require electrified door locking hardware and are fully controlled by the access control system. Exit Only and Emergency Exit Only doors are monitored by the access control system and do not require electrified locking. All doors will require a request-to-exit switch integrated with the door hardware and must be connected to a reader port on a Dual Reader Interface Module (LNL-1320).

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- e) Stairwell, Housing, and Roof Access doors must have sounders installed.
  - a) All other sounder applications are at the end-users discretion.
- 2. Preferred:
  - a) Additional access control system installations, specifically including interior access control partitioning and control, shall be determined by the functional and operational needs of the building owner and end-users. If implemented by the building owner and end-users, this additional access control system shall be considered above and beyond the minimum USC requirements. The building owner and end-users shall administer and manage the users and access rights for these additional card reader installations maintenance.
- 3. Disallowed:
  - a) Non-Lenel systems on the exterior of buildings.
- B. Quality Assurance requirements beyond standard 1-year warranty.
  - 1. None required.

### 4. PRODUCT REQUIREMENTS

Component		Required	Preferred	Disallowed
<b>Life Safety Access Control Enclosure</b>	Manufacturers	Life Safety Enclosure	None	All Others
	Component Characteristics	a) Life Safety Power FPO150-B1002D8PM8NL4E6M-WP-USC01 30"x23"x6.5" (3) Board, (6) Door Enclosure	C) Life Safety - USC03	All Others
		b) Life Safety Power FPO150/250-3D8P2M8NL4E8M2-WP-USC02 36"x30"x6.5" (8) BOARD, (16) Door Enclosure		
c) Life Safety Power FPO250/250-3D8P5M8PNLXE12M-WP-USC03 48"x36"x8" (12) BOARD, (24) Door Enclosure				
<b>Lenel</b>	Manufacturers	Lenel	None	All Others



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Component		Required	Preferred	Disallowed
<b>Access Control Software</b>	Component Characteristics	a) OnGuard PRO Edition b) Licensing per User and Card Reader	None	All Others
	Manufacturers	Lenel	None	All Others
<b>Intelligent System Controller (ISC)</b>	Component Characteristics	LNL-3300 Series 3	None	All Others
	Manufacturers	Lenel	None	All Others
<b>Dual Reader Interface Module</b>	Component Characteristics	LNL-1320 Series 3	None	All Others
	Manufacturers	Lenel	None	All Others
<b>Input Control Module</b>	Component Characteristics	LNL-1100 Series 3	None	All Others
	Manufacturers	Lenel	None	All Others
<b>Output Control Module</b>	Component Characteristics	LNL-1200 Series 3	None	All Others
	Manufacturers	Lenel	None	All Others
<b>Security Device Cabling</b>	Manufacturers	Connect-Air International WSECCOMP-2835 <i>or</i> Arrow Wire & Cable Inc ACP-3N5-1SH-9MR <i>or</i> All Star Cable C228184 <i>or</i> Windy City Wire 416400 WBT (Direct Burial)	None	All Others

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Component		Required	Preferred	Disallowed
	Component Characteristics	<p>a) Four element composite plenum rated cable, 4 conductors 18 AWG unshielded, 4 conductors 22 AWG unshielded, 4 conductors 22 AWG unshielded, and 6 conductors 22 AWG unshielded.</p> <p>b) Each element individually jacketed and cabled with an overall polyvinylchloride jacket for data communications and security applications manufacturer in the USA and listed (UL) CL3P or CMP c(UL)us 75 degree C, FT-6.</p> <p>c) Refer to 28 10 00 Design Requirements for standard composite 'L' cable types and color scheme.</p>	None	All Others
Card Reader	Manufacturers	Schlage	None	All Others
	Component Characteristics	<p>a) MT11 b) MT15 c) MTK15 d) MTMS15 (USC Housing)</p>	None	All Others
Intercoms	Manufacturers	a) 2N-IP-Verso	None	All Others

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	<p>Component Characteristics</p>	<p>b) 01380-001 - 2N IP Intercom License - Gold License</p> <p>c) 01273-001 - 2N IP Verso - Main unit with camera</p> <p>d) 02140-001 - 2N IP Verso - RFID 125kHz</p> <p>e) 01639-001 - 2N IP Verso multi-tech reader module</p> <p>f) 01259-001 - 2N IP Verso - Wiegand</p> <p>g) 01257-001 - 2N IP Verso - 2 inputs and 2 output relays</p> <p>h) 01260-001 - 2N IP Verso - Tamper switch</p> <p>i) 01285-001 - 2N IP Verso – Flush mount box</p> <p>j) 01289-001 - 2N IP Verso - Surface mount box</p> <p>k) 01294-001 - 2N IP Verso - Backplate for surface mount</p> <p>l) 814HOU-PRO-001-304 - Pedestal Pro – Exterior Mounted (Requires 2N 01285-001)</p> <p>m) 01668-001 - 2N Indoor Touch 2.0 Desk Master Station</p> <p>n) MicroSip 3.19.8 (Or</p>	<p>None</p>	<p>All Others</p>
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## USC BASIS OF DESIGN

Component		Required	Preferred	Disallowed
		<p>current) - VoIP Computer Software</p> <p>o) GSC-OM-E-1C Camera Connection</p> <p>p) ADV-CAM-E-1Y Genetec Advantage for Omnicast Enterprise Camera</p>		
<b>Request to Exit (REX)</b>	Manufacturers	None	None	None
	Component Characteristics	Included in the electrified locking door hardware.	<p>a) Included in the electrified locking door hardware</p> <p>b) Including delay timer (where required. Coordinate with FPM)</p> <p>c) DS150/DS160 (where required. Coordinate with FPM)</p>	None
<b>Low-Voltage Power Supply</b>	Manufacturers	<p>a) Life Safety (Integrated)</p> <p>b) Command Access PS480B (LRPS)</p>	None	All Others
	Component Characteristics	Class 2 rated where cabling will not be completely enclosed in conduit	May be shared with Intrusion Detection System	None
<b>Enclosure Tamper Switch</b>	Manufacturers	a) GRI TSC-20-24	None	All Others

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Component		Required	Preferred	Disallowed
<b>Alarm Contact Door Position Switch</b>	Component Characteristics	a) GRI: 4405A (surface-mounted) b) GRI: 4405-A with armored loop (overhead roll-up) c) GRI: 195-12-G (Recessed) d) Nascom Shark/MU (Aluminum Store front)	Double Pole Double Throw (DPDT)	All Others
	Manufacturers	IDEMIA	None	All Others
<b>Biometric Readers</b>	Component Characteristics	MPH-AC001A MorphoAccess – SIGMA Lite Proximity Series	Please consult with the Security Consultant and FPM LockShop for model specifics.	All Others
	Manufacturers			
<b>Wireless Reader Locks</b>	Component Characteristics	Schlage AD-400	a) Wireless (AD-400) for retrofits or where installation of homerun hardwiring would otherwise represent a substantial hurdle to completion of the project.  b) Required coordination: chassis, door locking function, lever design, finish, handing, backset, strike, latch bolt/deadbolt/dead latch functionality, door thickness, and keying.  c) Required AD-Series Reader Module shall be Multi-Technology  d) Design process for wireless includes field survey.	All Others
	Manufacturer	Schlage	a) Network integration:	All others

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Component		Required	Preferred	Disallowed
<b>Reader PIM (Panel Interface Module)</b>	Component Characteristics	PIM400- 1501	wireless: PIM400-1501 16 door intelligent controller; No more than 8 doors to be programmed per PIM; connects to the Lenel access control system via USC network. Handheld device for programming locksets (comes with SUS software for programming locksets).  b) Power: POE  c) Two network cables required per PIM  d) For multiple PIMs, only one PIM shall require the second network cable for programming  e) Tamper switch: monitored by Lenel.	All Others
	Manufacturers	Schlage		
	Component Characteristics	Antenna Types: ANT400-REM-CEILING ANT400-REM-HALL ANT400-REM-I/O ANT400-REM-I/O+6dB		
<b>Emergency Assistance Stations</b>	Manufacturers	Talk-a-Phone	None	All Others
	Component Characteristics	ETP-MTE-72-Eco Tower ETP-MTE-WP-ARM ETP-500C	None	All Others

### 5. INSTALLATION REQUIREMENTS

#### A. Required:

1. All ACP and low-voltage power supplies shall be installed in Electrical Rooms and not in IT rooms or closets.
  - a) Any deviations from ACP in electrical rooms must acquire pre-approval.
2. ACP and low-voltage power supply enclosures shall be installed on a fire-treated plywood backboard.
  - a) Leave at least one fire rating stamp unpainted and visible.
  - b) Where possible, this visible fire rating stamp should be within 6-inches along the edge of the plywood so that the installation of the enclosures does not cover it up.
  - c) Fire-treated plywood backboard shall be provided and installed by the General Contractor.

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- d) Fire-treated plywood shall be 4' x 8' x  $\frac{3}{4}$ " for smaller (USC01) sized panels.
  - e) Fire-treated plywood shall be 6' x 8' x  $\frac{3}{4}$ " minimum for larger (USC02, USC03) sized panels. (One sheet and a half).
3. ACP and low-voltage power supply enclosures layout and space requirements include:
- a) Minimize the use of wall space.
  - b) Attempt to not block future use of empty wall space by running a hardwired conduit raceway across an open wall space so that future projects can use that space.
  - c) ACP and low-voltage power supplies enclosures may be located higher or lower on walls to fulfill this direction.
4. Power and coordination requirements include:
- a) Provide hard-wired dedicated 120VAC power circuit(s) to low-voltage power supplies at ACP location.
  - b) Number of 120VAC power circuits required depends on the load of low-voltage power supplies on the project. The project should account for a minimum of one (1) 20A circuit.
  - c) Provide power from emergency generator back-up power where available.
  - d) Provide Low-voltage power supplies equipped with a minimum 12V 7AH battery backup.
5. Network coordination:
- a) ITS to provide a data network connection consisting of three CAT-5E for remodeling of an existing building and three CAT-6A for new construction. Cables to be routed from the Electrical Room or other installation location to the nearest designated MDF/IDF room for the ACP controller panel board.
6. Dual Reader Interface Modules shall be daisy-chained at the ACP location in lieu of distributing to security junction boxes at the access-controlled door locations.
7. Minimum 10' service loops are required at both ends of the homerun cable.
- B. Preferred:
- 1. Where space allows in new construction, especially projects with larger access control system implementations, create a separate dedicated security equipment room.
- C. Disallowed:
- 1. Installing high-voltage (120VAC) power inside ACP enclosures.
  - 2. Splitting conductors from the same cable jacket to run to two or more separate ACP or low-voltage power supply enclosures.

## 6. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:
  - 1. Required: Access control system devices, control equipment, door contacts, REX devices, electrified locks, sounders, cabinet tamper switches, power fail switches, etc.
- B. Documentation required:
  - 1. Test reports: Functional and operational acceptance testing for all components.
- C. Required testing protocols:
  - 1. Performed in accordance with USC Division 28 0800 Specifications.
  - 2. In-person witnessing: USC Admin Ops IT, USC FPM, USC PM, Security Consultant, and Security Integrator.

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3. The security Consultant shall be in charge of leading the testing and commissioning session, ensuring that the project is completed to USC Facility Design Guideline expectations.
4. All parties involved should be represented at commissioning.

**END OF DOCUMENT**



# USC BASIS OF DESIGN

## 28 1600 INTRUSION DETECTION

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
  - 1. For other related requirements, refer to Section 28 10 00 Design Requirements, Section 28 13 00 Access Control, and Section 28 23 00 Video Surveillance.
  - 2. For other related USC documents, refer to:
    - a) USC Division 28 Specifications
    - b) USC DPS Recommended Design Considerations for Security (CPTED)
- B. The following table summarizes the types of particular requirements identified within this Section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
Intrusion detection system devices and control equipment	Bosch	All other intrusion detection system devices and control equipment unless otherwise stated	Intrusion detection system devices and control equipment

- C. Integration with other systems:
  - 1. Work performed under separate Sections may connect to the work of Division 28 Sections for the purpose of auxiliary alarm monitoring. For example, a CO alarm in a Parking Structure may send primary alarm signals to a BMS or other Engineering system and send secondary alarm signals to Intrusion Detection systems for auxiliary alarm monitoring, notification, and response.
- D. Panic Alarms
  - 1. Panic Alarms (not associated with a healthcare setting) shall be provided and installed at the following locations: Money handling (collection), Counseling, and Human Resources. Other locations may be advised depending on building and architecture. Panic device locations shall be coordinated with USC DPS. Communication of alarm signals shall be to the existing USC DPS alarm receiver. Panic alarm devices and alarm signals shall be latching.
  - 2. Panic Alarms shall always be connected to an Intrusion Detection System for direct reporting to the Communications Monitoring Center (in PSA) even if an access control system is also present in the building.
  - 3. Wireless Panic Alarms are only to be used with prior written consent by the Owner.

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this Section:
  - 1. Required:
    - a) All requests for coordination between Division 28 and other entities shall be requested through the USC PM. For example, requests for USC or project design team review coordination and approval.
    - b) All requests shall be in writing, and discussions and decisions shall be documented in writing, listing the USC or project design team members involved and the date.
  - 2. Preferred:

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- a) Intrusion detection system installations shall be determined by the functional and operational needs of the building owner and end-users. If implemented by the building owner and end-users, this additional intrusion detection system shall be considered above and beyond the minimum USC DPS requirements. The building owner and end-users shall administer and manage the system.
  - b) PIN code issuance and management shall be by the building owner and end-users. Each authorized user must have a dedicated distinct PIN code.
  - c) Security Alarm Remote Monitoring: System security alarm and trouble signals shall be transmitted to the UPC DPS Communications Monitoring Center (PSA) via its integrated Digital Alarm Communicator Transmitter, which communicates over telephone lines. Intrusion detection system communications shall be compatible with the existing USC DPS Bosch D6600 alarm co.
  - d) No integration with Lenel OnGuard is expected or planned. Intrusion detection alarm monitoring is separate from access control. However, some intrusion detection devices may be monitored by both systems simultaneously.
3. Disallowed:
- a) Non-Bosch unless otherwise stated.
- B. Quality Assurance requirements beyond standard 1-year warranty:
- 1. No Warranty Requirements.

### 3. PRODUCT REQUIREMENTS

Component		Required	Preferred	Disallowed
<b>Intrusion Detection System</b>	Manufacturers	Bosch	-	All Others
	Component Characteristics	B9512G Series	Please consult with the Security Consultant and Administrative Operations IT for model specifics.	All Others
<b>Arming Station Keypad</b>	Manufacturers	Bosch	-	All Others
	Component Characteristics	B920 Series Keypad	Please consult with the Security Consultant and Administrative Operations IT for model specifics.	All Others
<b>Intrusion Detection Cabling</b>	Manufacturers	Windy City Wire WCW 444380 22/4 Unshielded Stranded Plenum	None	All Others

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Component		Required	Preferred	Disallowed
	Component Characteristics	<p>002340 4 conductors 18 AWG shielded</p> <p>444340 4 conductors 22 AWG shielded</p> <p>Plenum-rated cabling where cabling will not be completely enclosed in conduit</p>	None	All Others
<b>Low-Voltage Power Supply</b>	Manufacturers	<p>a) Bosch Power Supply</p> <p>b) Bosch Tamper Switch</p>	May be shared with Access Control System	All Others
	Component Characteristics	Class 2 rated where cabling will not be completely enclosed in conduit	Please consult with the Security Consultant and Administrative Operations IT for model specifics.	All Others
<b>Alarm Contact Door Position Switch</b>	Manufacturers	GRI / Bosch	None	All Others
	Component Characteristics	<p>a) GRI: 195-12-G (3/4" Recessed)</p> <p>b) GRI: 4405-A (surface-mounted)</p> <p>c) GRI: 4405-A with armored loop (overhead roll-up)</p> <p>d) Window Contacts Bosch RFDW-SM-A Wireless surface-mounted</p> <p>Includes roof hatches, skylights, operable ground-floor windows, and exterior roll-up doors where they occur in an alarmed zone.</p>	<p>Double Pole Double Throw (DPDT)</p> <p>Please consult with the Security Consultant and Administrative Operations IT for model specifics.</p>	All Others
<b>Motion Detector</b>	Manufacturers	Bosch	None	All Others

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Component		Required	Preferred	Disallowed
	Component Characteristics	Multi-technology detector: PIR and microwave BOSCH a) DS936	None	All Others
<b>Panic Alarms</b>	Manufacturers	Wired Duress Button W BOX Technologies a) 0E-HBMOMSD3T	None	All Others
		Wireless Duress Button BOSCH a) RFPB-SB	None	All Others
		Wireless Receiver BOSCH a) B810	None	All Others
	Component Characteristic	Panic alarm devices and alarm signals shall be latching	Please consult with the Security Consultant and Administrative Operations IT for model specifics.	All Others

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### 4. INSTALLATION REQUIREMENTS

#### A. Required:

1. IAP and low-voltage power supplies shall be installed in Electrical Rooms and not in the MDF/IDF rooms when the intrusion alarm panel's main focus is to monitor the exterior of the building.
  - a) Any deviations will require pre-approval.
2. IAP and low-voltage power supplies that are utilized to monitor specific suite(s) within a building must be installed above the finished ceiling within the suite(s).
  - a) Preferred: IAP and low-voltage power supplies shall be installed above the ceiling within break rooms or open spaces of the suite(s) for ease of serviceability.
  - b) Any deviations will require pre-approval.
3. For multi-level buildings the IAP and low-voltage power supplies shall be department specific per level and suite.
  - a) IAP and low-voltage power supplies shall be installed above ceilings.
  - b) Any deviations will require pre-approval.
4. IAP and low-voltage power supply enclosures shall be installed on a fire-treated plywood backboard.
  - a) Leave at least one fire rating stamp unpainted and visible.
  - b) Where possible, this visible fire rating stamp should be within 6-inches along the edge of the plywood so that the installation of the enclosures does not cover it.
  - c) Fire-treated plywood backboard shall be provided and installed by the General Contractor.
  - d) Fire-treated plywood shall be 4' x 8' x 3/4" when installed in electrical rooms or approved secure rooms.
  - e) Fire-treated plywood shall be 2' x 4' x 3/4" when above ceiling, if applicable.
  - f) IAP and low-voltage power supplies installed above ceilings do not require plywood but is preferred.
5. IAP and low-voltage power supply enclosures layout and space requirements include:
  - a) Minimize the use of wall space.
  - b) Attempt to not block any future use of empty wall space by running a hardwired conduit raceway across an open wall space so that future projects can use that space.
6. Power and coordination requirements include:
  - a) Provide hard-wired dedicated 120VAC power circuit(s) to low-voltage power supplies at the IAP location.
  - b) Number of 120VAC power circuits required depends on the load of low-voltage power supplies on the project. The project should account for a minimum of one (1) 20A circuit.
  - c) Provide power from emergency generator backup power if possible.
  - d) Provide sealed 12V 7AH battery backup for all low-voltage power supplies.
  - e) Provide 12VDC output from low-voltage power supplies to the associated powered security devices such as motion detectors. This power supply may be shared with access control system devices.
  - f) All electrical work must be performed in accordance with local, state, and national building and electrical code.
7. Network Connection
  - a) Provide 2 communication jacks for each IAP.

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- a) Provide one analog line for the Telephone line for the IAP controller panel board.
  - b) Provide one network connection for the LAN for the IAP controller panel board.
8. 10' Service loops are required at both ends of the homerun cable.
- B. Preferred:
- 1. Where space allows in new construction, especially in projects with intrusion detection systems and access control system implementations, create a separate dedicated security equipment room.
- C. Disallowed:
- 1. Installing high-voltage (120VAC) power inside IAP enclosures.
  - 2. Splitting conductors from the same cable jacket to run to two or more separate IAP or low-voltage power supply enclosures.
  - 3. Glass breaks detection sensors.
    - a) Note: Motion sensors shall be used in lieu of Glass Break Detection Sensors for window monitoring.
  - 4. Any non-Bosch IAP equipment that's compatible unless approved.
- 5. EVALUATION or COMMISSIONING**
- A. List of items or systems requiring testing, evaluation, verification, or commissioning:
- 1. Required: Intrusion detection system devices, control equipment, door contacts, motion detectors, panic buttons, keypads, cabinet tamper switches, power fail switches, etc.
- B. Documentation required:
- 1. Provided in accordance with USC Division 28 Specifications.
- C. Required testing protocols:
- 1. Performed in accordance with USC Division 28 Specifications.
  - 2. In-person witnessing: USC DPS, USC PM, Security Consultant, Administration Operations IT, and Security Integrator.

**END OF DOCUMENT**

# USC BASIS OF DESIGN

## 28 2300 VIDEO SURVEILLANCE

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
  - 1. For other related requirements, refer to Section 28 10 00 Design Requirements, Section 28 13 00 Access Control, and Section 28 16 00 Intrusion Detection.
  - 2. For other related USC documents, refer to:
    - a) USC Division 28 Specifications
    - b) USC DPS Recommended Design Considerations for Security (CPTED)
- B. The following table summarizes the types of particular requirements identified within this Section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
Video surveillance system devices and control equipment	Genetec	All other video surveillance system devices and control equipment	Video surveillance system devices and control equipment

- C. Recommendations related specifically to Parking Structures (May also apply to other areas related to surveillance):
  - 1. Parking associated with specific projects may be Structures or Subterranean. For any parking construction, USC Transportation Services needs to be involved in the decision-making and design approval process.
  - 2. Recommended: Off-white or bright color paint strip min 32" AFF to 72" AFF along every vertical surface to provide contrast and enhance lighting reflection.
  - 3. Provide minimum lighting levels as determined by safety requirements and security concerns. Coordinate with USC DPS.
  - 4. Provide and install screening along open spaces in the wall at the perimeter at ground level to block access into the structure by climbing in. Screening should not act as a ladder to access higher levels.
  - 5. Recommended elevators and stairwells to be on outside perimeter with translucent structure and glazing to facilitate observation from surroundings inside and outside the elevators and stairwells.
  - 6. These recommendations facilitate observation and surveillance through natural (naked eye) and electronic (video surveillance system) means.

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this Section:
  - 1. Required:
    - a) All requests for coordination between Division 28 and other entities shall be requested through the USC PM. For example, requests for USC or project design team review coordination and approval.
    - b) All requests shall be in writing, and discussions and decisions shall be documented in writing, listing the USC or project design team members involved and the date.
  - 2. Preferred:
    - a) USC DPS manages and provides direction for the use of video surveillance cameras on the exterior of campus buildings around USC campuses and

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their surrounding environments. Specific new construction projects shall coordinate any requirements, including additional video surveillance cameras associated with the campus master plan on their projects with USC DPS.

- b) Additional video surveillance camera system installations, specifically including interior video surveillance, shall be determined by the functional and operational needs of the building owner and end-users. If implemented by the building owner and end-users, this additional video surveillance system shall be considered above and beyond the minimum USC DPS requirements. The building owner and end-users shall administer and manage the dedicated building video surveillance camera system.

3. Disallowed:

- a) All Others.

B. Quality Assurance requirements beyond standard 1-year warranty:

- 1. No Warranty Requirements.

### 3. PRODUCT REQUIREMENTS

Video Surveillance		Required	Preferred	Disallowed
<b>System Software</b>	Manufacturers	Genetec	None	All Others
	Component Characteristics	Consult with Admin Ops IT for the latest software version	None	All Others
<b>System Hardware</b>	Manufacturers	None	None	All others
	Component Characteristics	a) Provided by USC Admin Ops IT	None	All Others
<b>Cameras (IP Interior)</b>	Manufacturers	Axis Communications	None	None
	Component Characteristics	a) Consult with Security Consultant for model specifics  b) Confirm requirements with USC Admin Ops IT  b) Subject to direction and product selection by building owner and end-users.	None	None
<b>Cameras</b>	Manufacturers	Axis Communications	None	None



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Video Surveillance		Required	Preferred	Disallowed
<b>(IP Exterior)</b>	Component Characteristics	a) Consult with Security Consultant for model specifics b) Confirm requirements with USC Admin Ops IT c) Subject to direction and product selection by building owner and end-users.	None	None
	Manufacturers	Genetec	AutoVu	All Others
<b>Cameras (LPR)</b>	Component Characteristics	a) Consult with Security Consultant for model specifics b) Confirm requirements with USC Admin Ops IT c) Subject to direction and product selection by building owner and end-users.	None	None
	Manufacturers	APC	None	All Others
<b>UPS</b>	Component Characteristics	a) SmartUPS 1500VA minimum. b) Sized to provide a minimum of 15 minutes of battery back-up for all attached video surveillance system components. c) Only required for SV16/SV32 Installation.	None	All Others
	Manufacturers	None	a) Veracity b) NVT	None
<b>POE Extenders</b>	Component Characteristics	Confirm requirements with USC Admin Ops IT	None	None

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### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Integration with existing Genetec Video at USC DPS Communications Monitoring Center is required for all interior and exterior cameras.
  - 2. Interior building owner and end-user cameras shall be monitored local to that system installation only.
  - 3. Installation of IP network-based video surveillance systems requires close coordination between the building owner and end-user, the Security Integrator, and USC ITS.
  - 4. Security Integrator is responsible for providing Genetec camera licensing for each camera provided, which is to be included in the project cost.
- B. Preferred:
  - 1. NVR may be located in the main University Data Center or in the building associated with the video surveillance system.
- C. Disallowed:
  - 1. All Others.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:
  - 1. Required: Video surveillance system devices, control equipment, camera locations, the field of view, and connectivity.
- B. Documentation required:
  - 1. Follow the checklist outlined in the attached testing and commissioning document.
  - 2. In-person witnessing: USC Admin Ops IT, USC PM, Security Consultant, and Security Integrator.
- C. Required testing protocols:
  - 1. Performed in accordance with USC Division 28 Specifications.

**END OF DOCUMENT**

# USC BASIS OF DESIGN

## 28 3100 FIRE DETECTION AND ALARM DESIGN REQUIREMENTS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 28 31 11.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	

- D. Additional Information:
  - 1. This design guide applies to Fire Alarm systems in all occupancies with the exception of group R division 3. This design guide applies to new fire alarm installations in new or existing buildings or modifications to existing fire alarm systems. This design guide applies to all systems, whether or not they are code required.
  - 2. Communication to USC proprietary monitoring center should be with a UDACT using contact id format. USC will supply 2 analog phone lines for the communicator.

### 2. PROCEDURAL REQUIREMENTS

- A. Standards and Code Requirements
  - 1. Required:
    - a) The system shall fully comply with the currently adapted codes and standards, if applicable.
  - 2. Preferred:
    - a) If any portions of this guideline are found to conflict with one another, formal clarification shall be requested by USC FMS. While request is under consideration, the design team shall assume that the stricter requirement /standard of care should apply.
  - 3. Disallowed:
    - a) This guideline is not to be considered as a means or implied approval to violate local and state general building or trade codes.
    - b) General code references to the "current edition of the code" are not acceptable.
- B. Design Criteria
  - 1. Required:
    - a) Plan Submittal Requirements:
      - 1) Design and installation of fire alarm systems within the City of Los Angeles shall meet the requirements of the currently adopted

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- California State and/or Los Angeles City Building and Fire Codes. The code(s) and/or standard(s), including edition year used to design the system shall be provided on the plans.
- 2) Plans for fire alarm systems shall be submitted to USC Engineering Services before submitting to Los Angeles City Fire Department.
  - 3) A minimum of two sets of plans shall be submitted for the initial plan check. Engineering Services shall retain one set.
  - 4) One set of manufacturers cut sheets and California State Fire Marshal (CSFM) listings for all devices and wire/cable used on the fire alarm system. The device used must be highlighted, along with alarm and standby currents. Devices provided by others, as part of the fire alarm system, must be included with the set (example: duct detectors).
  - 5) Fire Alarm plans shall be legible, orderly, and appropriately scaled. The scaled dimension of the floor plan shall not be less than 1/8"=1'. Plans shall be dedicated for Fire Alarm system detail only. All notes, details, changes and revisions must be incorporated onto the original plans.
  - 6) Installation shall not begin until plans have been approved by USC Engineering Services and the fire department. A complete set of approved plans shall be kept at the building site at all times. Contractors installing system without approved plans may be cited.
  - 7) Contractors will be notified when plans have been reviewed and are ready for pick-up from Engineering Services.
- b) System Designer Qualifications:
- 1) Design of fire alarm and emergency communication system plans shall be developed in accordance with the National Fire Alarm Code (NFPA 72) by persons who are experienced in the proper design, application and installation of fire alarm systems. The system designer shall be identified on the system design documents. Evidence of qualifications shall be provided when requested by Engineering Services.
    - i) Factory trained and certified in fire alarm system design.
    - ii) National Institute of Certification in Engineering Technologies (NICET) fire alarm certified minimum level III.
    - iii) C-10 (Electrical Contractor).
    - iv) Registered Fire Protection Engineer
- c) The followings notes shall be on the plans:
- 1) All exterior mounted equipment shall be listed as weatherproof.
  - 2) All fire detection devices that receive their power from the initiating device circuit or signaling line circuit of a fire alarm control unit shall be listed compatible for use with the control panel.
  - 3) Electrical power service shall be on a dedicated branch circuit(s). The circuit(s) and connections shall be mechanically protected (*Circuit breakers shall be locked in the on position with an approved mechanical clip*). Circuit disconnecting means shall have a red marking, shall be accessible only to authorized personnel, and shall be identified as "FIRE ALARM CIRCUIT CONTROL." The location of the circuit disconnecting means shall be permanently identified at the fire alarm control unit.
  - 4) All fire alarm systems shall test free of grounds.

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- 5) Voice evacuation messages shall be preceded and followed by a minimum of two cycles of the emergency evacuation signal.
  - 6) The alarm signal shall be a distinctive sound which is not used for any other purpose other than the fire alarm.
  - 7) Signaling devices shall produce a sound that exceeds the prevailing equivalent sound level in the room or space by 15 decibels minimum, or exceeds any maximum sound level with a duration of 60 seconds minimum by 5 decibels minimum, whichever is louder. Sound levels for alarm signals shall be 110 decibels maximum.
  - 8) The equipment shall be durably marked where plainly visible to indicate each circuit that is a power limited fire alarm circuit.
  - 9) Junction boxes and cover-plates shall be painted red or identified for fire alarm use.
  - 10) All outside control valves, flow switches and electrical junction boxes shall have electrically supervised covers. Electrical junction boxes may use tamper proof screws in place of electrical supervision. This provision is specifically directed to equipment used outside a building where tampering with the fire alarm systems is possible.
  - 11) Fire alarm equipment shall be installed and used in accordance with manufacturer's instructions included in the listing or label.
  - 12) Openings around penetrations through fire-resistant rated walls, partitions, floors or ceilings shall be fire stopped using approved methods to maintain the fire resistance rating.
  - 13) All wiring and cable shall be installed in accordance with the National Electrical Code.
  - 14) Fire Alarm conductors used in wet or underground locations shall be: Moisture-impervious metal-sheathed; Types MTW, RHW, RHW-2, TW, THW, THW-2, THHW, THHW-2, THWN, THWN-2, XHHW, XHHW-2, ZW; or of a type listed for use in wet locations.
  - 15) Power-limited fire alarm circuit conductors shall be separated by at least 2 in. non-power-limited fire alarm circuits.
  - 16) Exposed conductors or cables shall not be permitted.
  - 17) All area smoke detectors shall be removable from floor using smoke detector removal tool/pole
  - 18) Raceways shall not be supported by ceiling grids.
  - 19) Design and installation of fire alarm systems within the City of Los Angeles shall meet the requirements of the currently adopted California State and/or Los Angeles City Building and Fire Codes. The code(s) and/or standard(s), including edition year used to design the system shall be provided on the plans.
- d) The following information shall be on the plans:
- 1) Street and city address of the building site. Clearly indicate the purpose of the alarm system under a "Scope of Work" statement.
  - 2) Fire alarm contractors company name, address, business phone number, fax number. All State contractors must list license number with classification.
  - 3) Show a North reference.
  - 4) Provide a graphic scale
  - 5) All partitions extending to within 15 percent of the ceiling height (where applicable and when known)
  - 6) Provide symbols legend on all sheets where symbols are used.

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- 7) Provide a site plan.
- 8) Indicate occupancy of each building, floor or area.
- 9) Indicate all rated corridors and area separation walls.
- 10) Indicate the location of each smoke/fire damper on the plans.
- 11) Indicate the use of each room and provide room numbers if available.
- 12) Indicate the ceiling height in all areas exceeding 10'.
- 13) Provide a section view or note when ceiling mounted strobes are above 10'.
- 14) Provide a section view or note when area heat or smoke detectors are used under the following conditions:
  - i) When ceilings are greater than 10'.
  - ii) Slope ceilings with more than 1/2" per 1'.
  - iii) When irregular ceilings with beams, joists and obstructions are known to exist.
- 15) Provide elevation detail for device-mounting heights of manual pull boxes, audible/visible notification appliances and the mounting height of the main panel and any remote annunciators and/or microphones for voice evacuation systems.
- 16) Provide a Sequence of Operation in a matrix format, which lists the events that will occur when various initiating devices are activated.
- 17) Indicate locations of fire alarm monitor/control interfaces to other systems such as, but not limited to, hood extinguishing systems, fire/smoke/HVAC control systems and fire-extinguishing systems.
- 18) Indicate locations of fire alarm primary power disconnecting means
- 19) System riser locations
- 20) Type and number of system components/devices on each circuit, on each floor or level
- 21) Type and quantity of conductors and conduit (if used) for each circuit
- 22) Where known, acoustic properties of spaces
- e) Provide a Single Line/Riser Diagram including the following information:
  - 1) The number, type and size of conductors used.
  - 2) Denote all initiating devices.
  - 3) Denote all notification devices. If visual, indicate candela ratings adjacent to the device. If audio, indicate anticipated wattage.
  - 4) Indicate end of line resistors (EOL).
  - 5) Indicate the circuit number.
  - 6) Provide a separation between building, floors or areas.
  - 7) If auxiliary power supplies are used clearly indicate which circuits are powered from these devices.
  - 8) Indicate all new and existing devices on plan.
- f) Provide control unit diagrams for all control equipment (i.e., equipment listed as either a control unit or control unit accessory), power supplies, battery chargers, and annunciators and shall include the following information:
  - 1) Identification of the control equipment depicted
  - 2) Location(s) of control equipment
  - 3) All field wiring terminals and terminal identifications
  - 4) All circuits connected to field wiring terminals and circuit identifications
  - 5) All indicators and manual controls

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- 6) Field connections to supervising station signaling equipment, releasing equipment, or emergency safety control interfaces, where provided
- g) Typical wiring diagrams shall be provided for all initiating devices, notification appliances, remote indicators, annunciators, remote test stations, and end-of-line and power supervisory devices.
- h) System calculations shall be included as follows:
  - 1) Battery calculations
  - 2) Notification appliance circuit voltage drop calculations
  - 3) Other required calculations, such as line resistance calculations, where required

- 2. Preferred: None.
- 3. Disallowed: None.

### C. Special Facilities Management Services (FMS) criteria:

#### 1. Required:

- a) Any detector that is concealed or inaccessible from the floor shall have a remote indicator.
- b) Fire alarm document enclosure shall be mounted adjacent to the fire control panel and shall contain as-built fire alarm drawings on a rewritable DVD or USB memory stick, panel program, and warranty information. All preceding information shall also be downloaded into the cabinet's internal USB memory.
- c) In new or remodeled buildings, USC requires speakers so that mass notification will be possible in the future. Temporal 3 evacuation tone is required for alarm or alert signals where voice evacuation is not required.
- d) In new or remodeled residential occupancy spaces, system operated, combination photoelectric / carbon monoxide (CO) detectors shall be installed with a sounder base capable of producing both temporal 3 and temporal 4 alarm signals. The detectors shall be located;
  - 1) On the ceiling or wall outside of each separate sleeping area in the immediate vicinity of bedrooms
  - 2) In each room used for sleeping purposes.
  - 3) In each story within a dwelling unit, including basements but not including crawl spaces and uninhabitable attics. In dwellings or dwelling units with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

The CO element within the detector shall be replaceable at the end of the useful life cycle without requiring the replacement of the detector.
- e. In designated accessible for the hearing impaired residential occupancy units, an addressable control module and visible notification appliances shall be installed within the unit to activate upon activation of the local smoke / CO detector and upon building alarm. Visible notification appliances shall be located in each space provide with a smoke / CO detector.

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- f) In new buildings (or existing buildings being completely remodeled), USC requires area smoke detectors for damper control and HVAC shutdown wherever possible. See 2010 CBC 716.3.3.2 method 5 and 2010 CMC 609.0 exception 1 below.

*2010 CBC 716.3.3.2 Smoke damper actuation. The smoke damper shall close upon actuation of a listed smoke detector or detectors installed in accordance with Section 907.3 and one of the following methods, as applicable:*

- 1. Where a smoke damper is installed within a duct, a smoke detector shall be installed in the duct within 5 feet (1524 mm) of the damper with no air outlets or inlets between the detector and the damper. The detector shall be listed for the air velocity, temperature and humidity anticipated at the point where it is installed. Other than in mechanical smoke control systems, dampers shall be closed upon fan shutdown where local smoke detectors require a minimum velocity to operate.*
- 2. Where a smoke damper is installed above smoke barrier doors in a smoke barrier, a spot-type detector listed for releasing service shall be installed on either side of the smoke barrier door opening.*
- 3. Where a smoke damper is installed within an air transfer opening in a wall, a spot-type detector listed for releasing service shall be installed within 5 feet (1524 mm) horizontally of the damper.*
- 4. Where a smoke damper is installed in a corridor wall or ceiling, the damper shall be permitted to be controlled by a smoke detection system installed in the corridor.*
- 5. It is USC preference that this option be invoked: **Where a total-coverage smoke detection system is provided within areas served by a heating, ventilation and air-conditioning (HVAC) system, smoke dampers shall be permitted to be controlled by the smoke detection system.***

### **2010 CMC 609.0 Automatic Shutoffs.**

*Air-moving systems supplying air in excess of 2000 cubic feet per minute (944 L/s) to enclosed spaces within buildings shall be equipped with an automatic shutoff. Automatic shutoff shall be accomplished by interrupting the power source of the air-moving equipment upon detection of smoke in the main supply-air duct served by such equipment. Smoke detectors shall be labeled by an approved agency, approved and listed by California State Fire Marshal for air duct installation and shall be installed in accordance with the manufacturer's approved installation instructions. Such devices shall be compatible, with the operating velocities, pressures, temperatures, and humidities of the system. Where fire detection or alarm systems are provided for the building, the smoke detectors required by this section shall be supervised by such systems, and installed in accordance with NFPA 72 and the California Building and Fire Codes.*

*Exceptions:*



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1. *It is USC preference that this option be invoked: **When the space supplied by the air-moving equipment is served by a total coverage smoke-detection system complying with the California Fire Code, interconnection to such system may be used to accomplish the required shutoff.***
2. *Automatic shutoff is not required when all occupied rooms served by the air-handling equipment have direct exit to the exterior and the travel distance does not exceed 100 feet (30,480 mm).*
3. *Automatic shutoff is not required for Group R, Division 3 and Group U Occupancies.*
4. *Automatic shutoff is not required for approved smoke-control systems or where analysis demonstrates shutoff would create a greater hazard such as may be encountered in air-moving equipment supplying specialized portions of Group H Occupancies. Such equipment shall be required to have smoke detection with remote indication and manual shutoff capability at an approved location.*
5. *Smoke detectors that are factory installed in listed air-moving equipment may be used in lieu of smoke detectors installed in the main supply-air duct served by such equipment.*

### D. Calculation Requirements:

#### 1. Required:

- a) Provide a conduit fill calculation demonstrating that the maximum fill will not exceed 40% of the cross sectional area, as shown in Chapter 9 of the California Electrical Code.
  - 1) Provide battery load calculations including the following information:
  - 2) Show primary and secondary power sources.
  - 3) Indicate all devices used, including quantity, standby and alarm summations.
  - 4) For speakers, indicate and use the maximum anticipated wattage.
  - 5) Multiply your total Amperage by 20% in order to achieve a de-rated factor when sizing the battery.
  - 6) Identify battery size, voltage and connection configuration. For example: Install two 12 Ah batteries connected in parallel to supply 24 Ah at 12 volts.
  - 7) Provide a means of supervision for both the batteries and the battery charger. The method used shall be capable of detecting a failure of either the battery or the battery charger and must initiate a trouble signal.
- b) Provide voltage drop calculations including the following information:
  - 1) Indicate which particular circuit is calculated. If there is a question as to which circuit is the most demanding, provide calculations for any questionable circuits.
  - 2) Indicate the type of device, the quantity of devices calculated, and their respective current draws.
  - 3) Derive one calculation and demonstrate by using the appropriate formula.
  - 4) Show the formula used.
  - 5) Insert the numbers into the formula and demonstrate how the final answer was achieved.

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- 6) If using Table 9 of the NEC, the conductors shall be calculated using Direct Current Resistance at 75°C (167°F), with insulation (coated).
  2. Preferred: None.
  3. Disallowed: None.
- E. Intelligibility Design Requirements
1. Intelligibility shall first be determined by ensuring that all areas in the building have the required level of audibility.
  2. Voice communications using prerecorded and manual voice announcements shall be intelligible.
  3. Voice messages shall not be required to meet the audibility requirements for public, private, sleeping area or narrow band tone modes.
  4. Each space within a building, on a floor, shall be identified as either meeting the requirements for spaces that should not require verification of intelligibility based upon meeting the following design criteria;
    - a) Distance listener to speaker less than 30 ft (9.1 m) in the room (assuming proper audibility and low reverberation)
    - b) Ambient sound level is less than 50 dBA and the average SPL of the voice message is 10–15 dBA fast greater
    - c) No appreciable hard surfaces (e.g., glass, marble, tile, metal, etc.)
    - d) No appreciable high ceilings (i.e., ceiling height equals speaker spacing at a ratio of 1:1 optimal or 1:2 max)
  5. Spaces not conforming to the requirements of item 3 shall be identified and designated as Acoustically Distinguishable Spaces (ADS).
  6. ADS assignments shall be submitted for review and approval.
  7. Intelligibility design of ADSs shall be proven through the use of acoustic modeling software
  8. Preferred: EASE Evac
  9. Disallowed: None
- F. CO Detection Requirements
1. Residential occupancy buildings including dormitories shall be provided with CO detection within each sleeping area and at the location of any fossil fuel burning appliance or attached garage
- G. Low Frequency Sounders
1. Effective January 1, 2014, audible appliances provided for the sleeping areas to awaken occupants shall produce a low frequency alarm signal. This includes all notification appliances, smoke alarms and smoke detectors with sounder bases
- H. Fire Alarm Network Control Station
1. Where individual projects consists of multiple fire alarm control units serving multiple buildings on the same site, the fire alarm control units shall be networked together utilizing a dedicated high speed (single-mode) fiber network.
  2. A command and control desktop workstation shall be provided in a designated location known as a command center, to permit the monitoring, control and paging of each networked fire alarm control unit. The workstation shall include:
    - a) A Notifier ONYXWorks color graphics display with Notify IP software

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- b) Interfaced and supervised to the fire alarm system network via single-mode high speed fiber optic connection
- c) Contain a desktop microphone for manual paging
- d) 22" widescreen, touch screen monitor
- e) The color graphics system shall have the capacity for graphics, action message displays, and additional support screens.
- f) The color graphics system shall include user prompt messages enabling the operator to:
  - a. Selectively page speaker zones by building and by circuit
  - b. Silence signals in the affected area.
  - c. Perform manual operation of system control points.
  - d. Select other graphics displays.
  - e. Acknowledge alarms and return to normal conditions.
  - f. Select action message screens.
  - g. Perform editing functions.
  - h. Select list menus and perform control operations from list screens.
  - i. Perform operator log on/log off sequence.
  - j. Perform system bypass functions on a per device and per floor basis.
  - k. The system software shall include the following support graphics screens:
    - l. System Menu Screen – Allows access to operator log on/log off sequence, user authorization list, editing functions, and time and date setting.
    - m. List Menu Screen.
    - n. Symbol Library Screens to display all device symbols used in the system.
    - o. Detailed floor plans which include all initiating devices (smoke detectors, duct detectors, heat detectors, manual pull stations, monitor modules, and control modules)
  - p. Graphics Operating Modes:
    - q. Normal Operation – When no alarms are in progress, the terminal shall display a graphics screen menu or a graphics screen as manually selected by the operator. Each screen shall display, as a minimum, the current time, date and system status.
    - r. Alarm Mode – Upon activation of any alarm or trouble condition, the system status block shall flash and an audible tone shall be generated. The system point number and custom label shall also be displayed below the status block. The device in alarm or trouble shall flash until acknowledged. Each device in alarm shall be individually acknowledged.
    - s. Multiple Alarm Conditions – The color graphics system shall be capable of storing multiple alarms and indicating these pending alarms by the continued flashing of the system status block. Acknowledging the current alarm shall transfer the display to the next pending alarm indication.
  - t. The color graphics system shall conform to the following standards:
    - u. UL 864 listed for Fire Alarm Control Unit Accessory (UOXX).

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- v. The interface between the color graphics display terminal and fire alarm system shall be electrically supervised.

Quality Assurance requirements beyond standard 1 year warranty: Refer to Section 28 31 11.

### 3. PRODUCT REQUIREMENTS

- A. Fire Alarm Control Panel:
  - 1. Manufacturers:
    - a) Required: NFS2-3030.
    - b) Preferred: None.
    - c) Disallowed: Fire Warden Control Panels
  - 2. Component Characteristics:
    - a) Required:
      - 1) FACP shall be of addressable type and manufactures current model.
      - 2) The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
      - 3) The fire alarm control panel shall contain a history buffer that will be capable of storing up to 800 events. Up to 200 events shall be dedicated to alarm and the remaining events are general purpose. Systems that do not have dedicated alarm storage, where events are overridden by non-alarm type events, are not suitable substitutes. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.
      - 4) The fire alarm control unit shall contain two (2) high speed network communication modules capable of supporting wired and single mode fiber connection. For fire alarm network fiber cabling, refer to section 27 1000 Structured Cabling.
      - 5) The fire alarm control unit shall contain Digital Voice Command. The system shall be capable of providing one-way emergency voice communication capability on either an automatic or operator selectable zone-by-zone or "all-call" basis via the fire alarm speakers. Equipment shall be arranged so that speaker zones/buildings can be selectively addressed individually in any combination of individual zones, or on "all-call" basis, for "public address" paging, digitized voice message, or tone generator (universal temporal) signals.

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- Paging zone indicators on the FACU shall annunciate the active zone(s) in automatic and manual modes. Activation of a paging zone in automatic or manual mode shall be indicated by a red LED on the designated zone selector switch.
- 6) A minimum of one digital audio amplifier shall be provided for each floor of a building fire alarm system.
  - 7) One backup amplifier shall be provided for each set of primary amplifiers and shall be equal to the highest rated (wattage) primary amplifier provided. The backup amplifier shall automatically transfer in place of the defective amplifier.
  - 8) All amplifiers shall be mounted within dedicated amplifier cabinets. Notifier Model EQ cabinets sized to accommodate one back-up amplifier and associated building(s) amplifier(s). EQ cabinets shall comprise of a Model EQDR (door) and EQBB (Backbox).
  - 9) All remote amplifier cabinets shall be provided with Notifier Battery Cabinets BB-55 to allow for minimum of 55 amperage hour batteries.
  - 10) The voice communication system shall be arranged to automatically activate pre-recorded voice announcements upon alarm signal. Any modification to the approved pre-recorded messages shall be reviewed and re-approved by USC. In addition, a selector switch shall be provided for an "All Evac" function (universal temporal pattern three signal) to operate all speakers and strobe units throughout all buildings, simultaneously.
  - 11) A push-to-talk microphone shall be provided for manual live voice announcements in the FACU. A microphone within the designated campus command center shall take priority over all other announcements or messages generated from local fire alarm control units.
  - 12) The fire alarm control unit shall have sufficient quantities of bypass / selection switches for each emergency control function group (i.e. dampers per floor, elevator recall, door holder release, door lock release, etc.), audible and visible notification zone and manual control for each pressurization and exhaust fan.
  - 13) All specified control switches (speakers) shall be logically arranged on the FACU.
  - 14) Any switch out of the "AUTO" position shall cause the FACU trouble alarm to sound.
  - 15) Minimum enclosure for fire alarm control unit shall be Notifier CAB-C4 with appropriate filler plates, door and trim.
  - 16) Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
  - 17) Alarm verification can only be used with smoke detectors.
  - 18) A single fault on a circuit connected to the addressable devices shall not cause the loss of more than 50 addressable devices.

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- B. Fire Alarm Annunciator:
1. Manufacturers:
    - a) Required: Notifier.
    - b) Preferred: None.
    - c) Disallowed: None.
  2. Component Characteristics:
    - a) Required:
      - 1) Annunciation shall indicate the building floor, zone or other designated area from which the alarm or trouble signal originated and the device type.
    - b) Preferred: Custom Matrix Graphic per LAFD requirements.
    - c) Disallowed:
      - 1) Basic information on the text display is not acceptable (e.g., "AHU-1" is not acceptable).
- C. Notification Appliances:
1. Manufacturer:
    - a) Required: System Sensor
    - b) Preferred: None
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Notification appliances shall be white and void of any markings or lettering.
      - 2) Audible notification appliances shall be high fidelity speakers capable of a minimum of 89dBA @ 10' (UL Reverberant)
      - 3) Audible or audible / visible notification appliances shall mount to a 5 in. square x 2.875 in. deep metal box with a 5 in. x 4 in. square extension ring.
      - 5) Speakers shall be 70 VRMS, low profile multi-taps with a range from ¼-watt to 2-watts
      - 4) Visible notification appliances shall utilize a clear lens
    - b) Preferred: Ceiling Mount
    - c) Disallowed:
      - 1) Notification appliances that contain the word "FIRE" or "ALERT"
      - 2) Visible notification appliances within stairwells and elevator cars.
- D. Fire Alarm Document Enclosure
1. Manufactures:
    - a) Required: Space Age Electronics #SSU00685 Fire Alarm Storage Cabinet Red with internal 4GB memory accessible through USB B connector.

## 4. INSTALLATION REQUIREMENTS

- A. Required:
1. Installation Personnel:
    - a) Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection and testing of fire alarm systems.

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Examples of qualified personnel shall include, but not be limited to, the following:

- 1) Factory trained and certified by the manufacturer in fire alarm system installation, maintenance and programming on the particular model of equipment being installed.
  - 2) National Institute of Certification in Engineering Technologies (NICET) fire alarm certified minimum level II.
  - 3) C-10 (Electrical Contractor).
  - 4) California Registered Apprentice program.
2. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. Fasteners and supports shall be adequate to support the required load.
  3. Fiber optic networking cabling from the in-building IDF to the fire alarm control unit shall be the responsibility of the fire alarm system installer.
- B. Preferred: Factory trained and certified by the manufacturer in fire alarm system installation, maintenance and programming on the particular model of equipment being installed.
- C. Disallowed:
1. Detectors shall not be supported solely by suspended ceilings.

### 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Refer to Section 28 31 11.
- B. Documentation required: Refer to Section 28 31 11.
- C. Required testing protocols: Refer to Section 28 31 11.

**END OF DOCUMENT**

# USC BASIS OF DESIGN

## 28 3111 DIGITAL ADDRESSABLE FIRE ALARM SYSTEMS

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 28 31 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X		X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) This section includes the furnishing, installation, connection and testing of the microprocessor controller, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system.
    - b) The fire alarm system shall comply with requirements of NFPA Standard 72 except as modified and supplemented by this specification.
    - c) The system shall be electrically supervised and monitor the integrity of all conductors.
    - d) The system, its components and its installation shall be in compliance with the required UL listing.
  - 2. Preferred: None.
  - 3. Disallowed: None.
- B. Codes and Standards:
  - 1. Required:
    - a) Comply with the following:
      - 1) NFPA 13, 25, 72 and 2001
      - 2) ASME 17.1
      - 3) California Building Code Title 24 Part 2
      - 4) California Electrical Code Title 24 Part 3
      - 5) California Mechanical Code Title 24 Part 4
      - 6) California Fire Code Title 24 Part 9
      - 7) City of Los Angeles Building Code
      - 8) City of Los Angeles Fire Code
  - 2. Preferred: None.
  - 3. Disallowed: None.



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- C. Quality Assurance requirements beyond standard 1 year warranty: Standard year parts and labor plus any service.

### 3. PRODUCT REQUIREMENTS

#### A. Fire Alarm Control Panel:

- 1. Manufacturers:
  - a) Required:
    - 1) Notifier.
  - b) Preferred: None.
  - c) Disallowed:
    - 1) Fire Warden Control Panels.
- 2. Component Characteristics:
  - a) Required:
    - 1) The fire alarm control panel shall be capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs).
    - 2) Control Panel shall be addressable.
  - b) Preferred: None.
  - c) Disallowed:
    - 1) Systems that do not allow or have restrictions in, for example, the amount of t-taps, length of t-taps etc., are not acceptable.

#### B. Communicator:

- 1. Manufacturers:
  - a) Required: Notifier.
  - b) Preferred: None.
  - c) Disallowed: None.
- 2. Component Characteristics:
  - a) Required:
    - 1) The communicator shall be Universal Digital Alarm Communicator Transmitter (UDACT).
  - b) Preferred: None.
  - c) Disallowed: None.

#### C. Technical Support:

- 1. Manufacturers:
  - a) Required:
    - 1) Beginning with Substantial Completion, provide software support for five years.
  - b) Preferred: None.
  - c) Disallowed: None.

#### D. Upgrade Service:

- 1. Manufacturers:
  - a) Required:
    - 1) Update software to latest version at Project completion. Install and program software upgrades that become available within three years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
  - b) Preferred: None.

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- c) Disallowed: None.
- E. Special Tools:
  - 1. Manufacturers:
    - a) Required:
      - 1) Supply three complete sets of any special tools or keys for normal operation and maintenance of the system.
    - b) Preferred: None.
    - c) Disallowed: None.

### 4. INSTALLATION REQUIREMENTS

- A. Required:
  - 1. Installation – General:
    - a) All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.
    - b) All wiring shall be in conduit.
    - c) All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.
    - d) Address ID Labels to identify all addressable devices and terminal cabinets.
    - e) Minimum ¼ inch letters or 18 font that can be read from the floor.
    - f) Use a label maker not a sharpie.
  - 2. Control Pane Location:
    - a) FACP shall be located near the main entrance of the building.
    - b) Where multiple entrances to a building, use the address side entrance.
    - c) A code modification will be required in order to mount the FACP in another location.
  - 3. Mounting:
    - a) Top of cabinet installed no more than 72 inches above finish floor.
  - 4. Communicator:
    - a) The UDACT shall be mounted within the FACP cabinet whenever possible.
    - b) Two phone lines will be required for the UDACT.
  - 5. Extra Materials:
    - a) Provide additional 10% of detection and alarm devices and control panel capacity/connections to provide flexibility to add/change the system as the design progresses.
    - b) Provide spare detectors; pull stations, strobes, and speakers, minimum of 10 each but not less than 5% of total installed.
  - 6. Conductors, Wire, Conduit:
    - a) Fire alarm system to be installed in conduit or raceway system.
    - b) Conduit shall be ¾-inch minimum.
    - c) Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-55.

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- d) Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
  - e) Install cables in raceways except within consoles and cabinets. Conceal raceways except in unfinished spaces.
  - f) Comply with requirements for raceways and boxes specified in Division 16 Section "Raceways and Boxes."
  - g) Furnish all conductors, equipment, plugs, terminal strips, etc., and labor to install a complete and operable system. All cable conductors to be color coded and numbered for identification at all terminals. Green for grounding conductor. White for grounded conductor. Do not loop through devices or T-Tap conductors. Maintain continuous shields throughout system and ground shield to main control panel.
7. Training:
- a) Submit a proposed training agenda for the Owner's Representative for review within 30 days of date of commencement specified in the Notice to Proceed. The approved training agenda shall be submitted 14 days prior to the final system acceptance test.
  - b) Provide training for three University staff with personal on job instruction provided by competent engineers representing the manufacturer.
  - c) Provide each operator with complete, printed operating instructions and subsystem description in manual or handbook form.
  - d) Provide one 2 hour training session. Sessions scheduled to suit requirements shall be scheduled at the time of the final acceptance test and during the first six months of operation.
  - e) Certification of successful completion of training. If in the opinion of the training instructor any personnel assigned are not qualified to be certified, the training instructor shall notify the University.

B. Preferred: None.

C. Disallowed:

- 1. Conduit shall not enter the fire alarm control panel or any other remotely mounted control panel equipment or back boxes, except where conduit entry is specified by the FACP manufacturer.
- 2. Conduit Fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.

## 5. EVALUATION or COMMISSIONING

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Fire Alarm System.
- B. After all equipment specified herein for each system has been installed and is in operating condition, conduct performance tests to determine if the installation and components comply with these specifications.

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- C. Furnish competent personnel, all test material and approved test instruments and conduct the tests.
- D. Test and verify proper reporting of the Life Safety Fire Alarm System communication to the University Park Campus monitoring station.
- E. Test Record System certification and documentation of system testing by the contractor required by these specifications shall be submitted to the Owner's Representative for review and approval at least 14 days prior to the final acceptance test.
- F. Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- G. After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
  - 1. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.
  - 2. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72. Minimum required tests are as follows:
    - a) Verify the absence of unwanted voltages between circuit conductors and ground.
    - b) Test all conductors for short circuits using an insulation-testing device.
    - c) With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.
    - d) Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
    - e) Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
    - f) Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors 'with actual products of combustion.
    - g) Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.
    - h) Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
    - i) Tag all equipment, stations, and other components at which tests have been satisfactorily completed
- H. Documentation required:
  - 1. Report of Pretesting:

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- a) After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.
2. Report of Tests and Inspections:
  - a) Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of test.
- I. Required testing protocols:
  1. General: N/A

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 32 0000 EXTERIOR IMPROVEMENTS

### 1. OVERVIEW

- A. Purpose: USC Preferences and requirements are indicated in this document.
- B. For other related requirements, refer to all product based sections.
- C. The desire is to consistently match the existing landscape themes at USC. For area repairs, match existing tree and shrub sizes and varieties. Match grass and ground cover types. New construction must be compatible with existing campus themes. New construction need not match area exactly but must be consistent with themes across campus. For other related requirements, refer to all product based sections.
- D. Minimum Design Criteria for Landscape: Landscape design shall consider selection of materials that are generally water efficient, pest-resistant, low maintenance and that are appropriate to the surrounding campus environment or site conditions as well as being consistent with existing themes. Ground cover shall be designed to minimize erosion. All trees, shrubs, lawns, and ground cover to be provided shall be of varieties having compatibility with existing soils, available sunlight, existing foliage themes, and irrigation requirements. Sizes of materials selected should be adequate to assure their survival. Use of small plants is encouraged to maximize adaptability to site conditions. All plant materials shall be guaranteed for ninety (90) days after the owner's acceptance of work. Tree should be chosen in combinations to provide color year round and minimal litter such as tree fruits and flowers. Desire is to provide variations in color with minimal clean-up.
- E. Landscape color must be appropriate for soil, season, available irrigation, sunlight, and must be disease resistant. Use color with healthy root structure. Use of color is encouraged around entrances and focal points.

### 2. PROCEDURAL REQUIREMENTS

- A. Standards and Code Requirement
  - 1. Comply with the current applicable provisions of the following, with applicable codes and regulations of the City of Los Angeles and as specified.
  - 2. "UPC" - Uniform Plumbing Code published by the Association of Western Plumbing Officials
  - 3. "ASTM" - American Society for Testing and Materials
- B. Ordinances and Regulations
  - 1. All local, municipal and state laws, and rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these Specifications and their provisions shall be carried out by the Contractor. Anything contained in these Specifications shall not be construed to conflict with any of the above rules and regulations or requirements of the same.

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However, when the Specifications and Drawings call for or describe materials, workmanship or construction of a better quality or higher standard than is required by the above rules and regulations, the provisions of the Specifications and Drawings shall take precedence.

C. Permits and Fees

1. The Contractor shall obtain and pay for any and all permits and all inspections as required.

D. Manufacturer's Directions

1. Manufacturer's directions and detailed Drawings shall be followed in all cases where the manufacturers of articles used in this contract furnish directions covering points not shown in the Drawings and Specifications.

E. Clarification

1. If any portions of this guideline are found to conflict with one another, formal clarification shall be requested from FPM Facilities. While request is under consideration, the design team shall assume that the stricter requirement/standard of care should apply

F. Design Criteria

1. All plans should include a North Arrow and Scale Bar where appropriate.
2. Include site diagrams to indicate which part of a site the plans are referencing.
3. Schedules of Materials, Furnishings, Plants, etc. should only contain items referred to within the plans.
4. Plans should include total square footage of planted area versus total area, and show the percentage of planted area.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 32 0190 OPERATION AND MAINTENANCE OF PLANTING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. Summary: Provide continuous Landscape Maintenance, complete as specified during progress of work, after installation, and for a period of 90 days after Preliminary Acceptance. Hand over Maintenance Manual together with a copy of the specifications below permanent Landscape Maintenance Contractor.
- C. Related Documents:
1. 32 8400 - "Planting Irrigation."
  2. 32 9000 - "Planting."
  3. 32 9113 - "Soil Preparation."
- D. References:
1. ANSI A300 Parts 1 through 6 Tree Pruning through Tree Planting. ISA Website under Best Management Practices
  2. CTLA Standards (council of tree and landscape assessors)
  3. Arboriculture: Care of Trees, Shrubs and Vines in the Landscape R. Harris 4th edition.
- E. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring evaluation/testing
X	X	X	X

### 2. PROCEDURAL REQUIREMENTS

- A. Quality Control Submittals:
1. Schedule of maintenance operations and monthly status report including list of equipment, materials, proposed for the job and watering schedule.
  2. Licenses, permits and insurances required by the City having jurisdiction over the Project, the State or Federal government pertaining to maintenance work.
  3. Monthly record of all herbicides, insecticides, and disease control chemicals used for the project.
  4. Written application recommendation by a licensed agricultural pest control advisor for all weed, pest, and disease controls restricted by the Director of Agriculture proposed for this work.
- B. Project Close-out Submittal:
1. Include in a single, 3-ring binder a landscape maintenance manual containing an indexed collection of all schedules, records, and permits listed above, as well as



## USC DESIGN GUIDELINES

documentation of accepted condition of planting and irrigation at Final Acceptance.

### C. Personnel Quality Assurance:

#### 1. Required:

- a) Experience: The landscape contractor or maintenance subcontractor shall have a full-time employee assigned to the job as foreman for the duration of the contract. Contractor shall have a minimum of four (4) years of experience in landscape maintenance supervision, with experience or training in pruning, pest control, soils, fertilizers, and plant identification.
- b) Labor Force: The landscape maintenance labor force shall be thoroughly familiar with, and trained in, the work to be accomplished, and shall perform the task in a competent, efficient manner acceptable to the Owner's Representative. Labor force shall have knowledge of integrated pest management procedures.
- c) Supervision: The foreman shall directly supervise the work force at all times. Notify Owner's Representative of all changes in supervision.
- d) Identification: Provide proper identification at all times for landscape maintenance firm's vehicles and labor force. Be uniformly dressed in a manner satisfactory to the Owner's Representative.

#### 2. Preferred: None

#### 3. Disallowed: Any deviation from the above requirements is not allowed.

### D. Project / Site Conditions

1. Site Visit: Prior to maintenance period, visit and walk the site with the Owner's representative to clarify scope of work and understand existing project/site conditions.
2. Documentation of Conditions: Document general condition of trees, shrubs, vines, and groundcovers recording all plant materials which are healthy, thriving, damaged, dead or dying.
3. Irrigation System: Document general condition of existing irrigation system, making sure that faulty electrical controllers, broken or inoperable sprinkler head or emitters are reported.

### E. Equipment

1. General: Use only the proper tool for each job. Maintain tools in sharp, properly functioning condition. Clean and sterilize pruning tools prior to usage.
2. Insect/Disease Prevention: Take all measures to prevent introduction of insect or disease-laden materials onto the site. Refer to Section 32 9000 – Planting.

### F. Sequencing and Scheduling

1. Perform all maintenance during hours mutually agreed upon between Owner's representative and Contractor.
2. Work force shall be present at the project site at least once a week and as often as necessary to perform specified maintenance in accordance with the approved maintenance schedule.

### G. Warranty

1. Specific Requirements: Refer to Planting – Section 32 9000.

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### 3. PRODUCT REQUIREMENTS

- A. General: All material and equipment shall be provided by the Contractor, except as specified below:
- B. Water: Clean, potable, and fresh, as available from Owner.
- C. Fertilizers:
  - 1. Tightly compressed, slow-releasing and long-lasting complete fertilizer tables bearing manufacturer's label of guaranteed analysis of chemical present.
  - 2. Balanced, once-a-season, application, controlled-release fertilizers with a blend of coat pills which supply controlled-release nitrogen, phosphorus.
- D. Herbicides, Insecticide, and Fungicides:
  - 1. Best quality materials with original manufacturer's containers, properly labeled with guaranteed analysis.
  - 2. Use non-staining materials.
- E. Replacement Tree Guys, Ties, and Wires:
  - 1. Match originally accepted existing materials on the site if necessary, until trees are properly rooted. Remove all stakes when tree can stand on its own, sometimes up to a year or more.
  - 2. At no time should wires or guy wiring be used. Guy wires are a known trip and fall hazard and should be avoided.

### 4. EXECUTION

- A. Establishing the Maintenance Period:
  - 1. As soon as planting is substantially completed per documents, hold preliminary review to determine the condition of the work.
  - 2. Date of review: Notify Landscape Architect at least five (5) working days prior to anticipated date of review.
  - 3. Punch List: Prior to Preliminary Acceptance, the USC Irrigation and Landscape Supervisors must inspect the project with the contractor and make a punch list of items that need to be corrected.
  - 4. Beginning of Maintenance Period: The date on which the Landscape Architect issues letter of Preliminary Acceptance to the Contractor.
- B. Protection:
  - 1. Protect all new and existing planting areas from damage of all kinds from beginning of work until sufficiently established or until Final Acceptance.
  - 2. Temporary Protection:
    - a) Provide temporary protection fences, barriers, and signs as required for protection.
  - 3. Tree Protection Zone (TPZ):
    - a) Temporary, protective fencing shall be installed around any existing tree that is to be preserved on the project site. The fencing must be made of a material that is highly visible and must be placed at no less than the dripline of the tree, whereby no encroachment can be made. Absolutely, no activity shall take place within the TPZ.

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- b) A change of grade in the TPZ is strictly forbidden. Topsoil, sand, fuel, oil, vehicles, equipment, and any waste material shall not be stored within the TPZ.
  - c) If it is determined that traffic encroachment within the dripline of a tree on site is unavoidable, a six (6) to twelve (12) inch layer of temporary mulch shall be placed over the affected area to disperse the weight of traffic and equipment. Additional weight dispersal and mobility may require the placement of large sections of plywood in addition to the layer of mulch to alleviate soil compaction issues.
  - d) Construction mulching and plywood must be removed carefully at the completion of the project so as to not damage the roots and tree.
- C. Replacements:
- 1. Immediately treat or replace all plants which become damaged or injured as a result of Contractor's operations or negligence, as directed by Landscape Architect, at no cost to Owner.
  - 2. Replacement plants shall match size, condition and variety of plants replaced/
  - 3. If tree failure occurs as a result of Contractor's negligence or failure to follow protection guidelines, Contractor shall pay the value of the tree and pay for the reimbursement equal to the trunk size of the tree that was lost. This is also known as an inch-for-inch basis. Follow CTLA standards.

## 5. MAINTENANCE

- A. Watering, Irrigation and Drainage:
- 1. Maintain originally called for depth of mulch to reduce evaporation and frequency of watering.
  - 2. Species, sizes of plants, container sizes and orientation shall dictate frequency of watering. Submit to Owner a watering schedule for different seasonal requirements.
  - 3. During the course of ongoing construction, trees shall be irrigated at least once a week through manual watering if mechanized watering is unavailable. Twice a week watering shall be applied in warmer periods. If the root zone has been compacted, the contractor will apply vertical mulching techniques for the affected area
  - 4. If drainage has been affected, the contractor shall identify where the impact has occurred and restore proper drainage through aeration, grade changes, or as directed by the USC Certified Arborist.
- B. Resetting:
- 1. Reset plants to proper grades and upright position.
- C. Weed Control:
- 1. All areas between plants, including watering basins, shall be weed free at all times.
  - 2. We recommend the use of hand weeding as the primary means of weeding, Use only recommended and legally approved herbicides to control weed growth if hand weeding is not adequate.
  - 3. Avoid frequent soil cultivation that destroys shallow roots and breaks the seal of pre-emergent herbicides.

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4. We recommend Whittier Fertilizer mulch called "Supreme "Walk -On" Bark" comprised of shredded bark nuggets and cambium made up of Douglas Fir, Larch, and Ponderosa Pine. Size= 1/2" to 1" by 1" to 2" length.
- D. Pruning
1. A Certified Arborist must be present during tree pruning operations. Early tree training is crucial to establish a good mature tree structure.
  2. Prune trees to select and develop permanent scaffold branches that are smaller in diameter than the trunk or branch to which they are attached. Healthy and aesthetically balanced spacing that is correct for the type, style, and species of tree shall be maintained.
  3. Prune trees to eliminate diseased or damaged growth, and narrow V-shaped branch forks that lack strength. Reduce toppling and wind damage by thinning out crowns.
  4. Prune trees to maintain growth within space limitations, maintaining a natural appearance and balancing crown with roots.
  5. No stripping of lower branches ("raising up") of young trees will be permitted.
  6. Retain lower branches in a "tipped back" or pinched condition to promote caliper trunk growth (tapered trunk). Do not cut back to fewer than six buds or leaves on such branches. Only cut lower branches flush with the trunk after the tree is able to stand erect without staking or other support.
  7. Tip prune and shape evergreen trees when necessary to prevent wind and storm damage. Do not prune to thin out trees. Do primary pruning of deciduous trees during the dormant season. Do not permit any pruning of trees prone to excessive bleeding during growth season.
  8. Prune damaged trees of those that constitute health or safety hazard at any time of year as required.
  9. Make all cuts clean and close to the trunk, without cutting into the branch collar. "Stubbing" will not be permitted. Cut smaller branches flush with trunk or lateral branch. Make larger cuts (1 in. in diameter or larger) parallel to shoulder rings, with the top edge of the cut at the trunk or lateral branch.
  10. Branches too heavy to handle shall be precut in three stages to prevent splitting or peeling of the bark. Make the first two cuts 19 in. or more from the trunk to remove the branch. Make the third cut at the trunk to remove the resulting stub.
  11. Do not prune or clip shrubs into balled or boxed forms.
  12. Take extreme care to avoid transmitting disease from one infected plant to another. Properly sterilize pruning tools before going from one infected plant to all other plants. Use Bordeaux bleach & Water or torch to sanitize pruning tools.
  13. Remove all dead branches from vines and prune them to control their size at least once a year.
  14. Remove spent flower on a weekly basis.
  15. Cut grasses back once a week to improve density and attractiveness.
- E. Staking of Trees
1. Inspect Lodgepole stakes at least once a month to check for rubbing that causes bark wounds. Remove nursery stakes immediately after installation. Remove other stakes of guys once tree has rooted properly, usually after 1 year of installation.
  2. Contractor to communicate with the USC Certified Arborist and USC Landscape Supervisor on university procedures for staking and guying.

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- F. Monitoring
  1. Symptoms: Be alert to symptoms of damage to existing plantings as evidenced by wilting, unseasonal or early flowering or loss of leaves, and insect or disease infestation due to declining vigor.
  2. Monitor weekly the proper function of irrigation system and proper pot drainage.
  3. Notification: Submit in writing of evidences of declining vigor immediately upon discerning the problem. Take appropriate interim measures to mitigate the severity of the problem as specified in this section.
  4. Proposal: Submit written proposal and cost estimate for the correction of all conditions before proceeding with permanent correction work.
  
- G. Replacements
  1. Replace dead and missing plants after obtaining Owner's agreement to pay for replacement.
  2. Damages due to Contractor's negligence shall be paid for without charge to Owner.
  
- H. Insects, Pests, and Disease Control
  1. Inspection: Inspect all plant materials for signs of stress, damage and potential trouble from the following:
    - a) Presence of damaging insects, gophers, snails, and slugs in planting areas.
    - b) Discolored or blotching leaves.
    - c) Unusually light green or yellowish green color inconsistent with normal green color of leaves.
  2. Personnel: Only licensed, qualified, trained personnel shall perform spraying for insect, pest, and disease control. Preference is given toward an integrated pest management (IPM) system for the control of pest and insects. Chemicals use or herbicides shall be non-toxic and safe.
  3. Application: Spray with extreme care to avoid all hazards to any person or pet in the area of adjacent areas. NO nicotinoid-based sprays while any plants are in bloom as they have a direct relationship with bees and Colony Collapse Disorder aka CCD
  
- I. Irrigation System
  1. General
    - a) Repair without additional charge to Owner all damages to system caused by Contractor's operations. Perform all repairs within one (1) watering period.
    - b) Report promptly to Owner's Representative all accidental damage not resulting from Contractor's negligence or operations.
    - c) Do not run the irrigation system during rainy season. Set and program automatic controllers for seasonal water requirements.
    - d) Twice a month, use a probe or other acceptable tool to check the root ball moisture of representative plants as well as the surrounding soil. Do not overwater.
  2. Cleaning and Monitoring the System:
    - a) Continually monitor the irrigation systems to verify that they are functioning properly as designed. Make program adjustments required by changing field conditions.

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- b) Clean filter and strainer at least once a month and as often as necessary to keep the irrigation systems free of sand and other debris.
- J. Termination of the Maintenance Period
- 1. Final Acceptance Procedure:
    - a) Work will be accepted by the Landscape Architect and FPM Facilities (Grounds) Associate Director upon satisfactory completion of work, including maintenance period, but exclusive of replacement of materials under warranty.
    - b) Submit a written request to Landscape Architect for review for Final Acceptance at least five (5) working days prior to anticipated Final Review date, which is at the end of the Maintenance Period.
  - 2. Corrective Work:
    - a) Work requiring corrective action or replacement shall be performed within ten (10) calendar days after the Final Review.
    - b) Perform corrective work and materials replacement in accordance with the Drawings and Specifications, and shall be made by the Contractor at no cost to the Owner.
    - c) After corrective work is complete, the Contractor shall again request a Final Review for Final Acceptance as outlined above.
    - d) Continue maintenance of all landscaped areas until such time as all corrective measures have been completed and accepted.
  - 3. Conditions for Acceptance of Work at End of Maintenance Period:
    - a) Each plant shall be alive and thriving, showing signs of growth and no signs of stress, disease, or any other weaknesses.
    - b) Replace all plants not meeting these conditions. An additional Warranty Period equal in length to the original shall be commenced for all such lant and planted areas.
  - 4. Final Acceptance Date: The date on which the Landscape Architect issues a Letter of Final Acceptance. Upon Final Acceptance, the Owner will assume responsibility for maintenance of the work.
- K. Cleaning
- 1. Dispose of all pruned branches and leaves, sweep all walkways and rake smooth all mulched areas.
  - 2. Remove from the site all containers and evidence of maintenance activities.
- L. Close Out
- 1. Landscape Maintenance Record: Submit binder to Owner with all documentation and records required and utilized during the maintenance period.
  - 2. Keys and Identification: Return all keys and identification materials supplied by Owner for the purpose of site access.
  - 3. Submit two (2) copies of color-coded irrigation controller charts. Laminate 8½x11 paper.

END OF SECTION 32 0190

# USC DESIGN GUIDELINES

## 32 0190.23 PRUNING

### 1. GENERAL

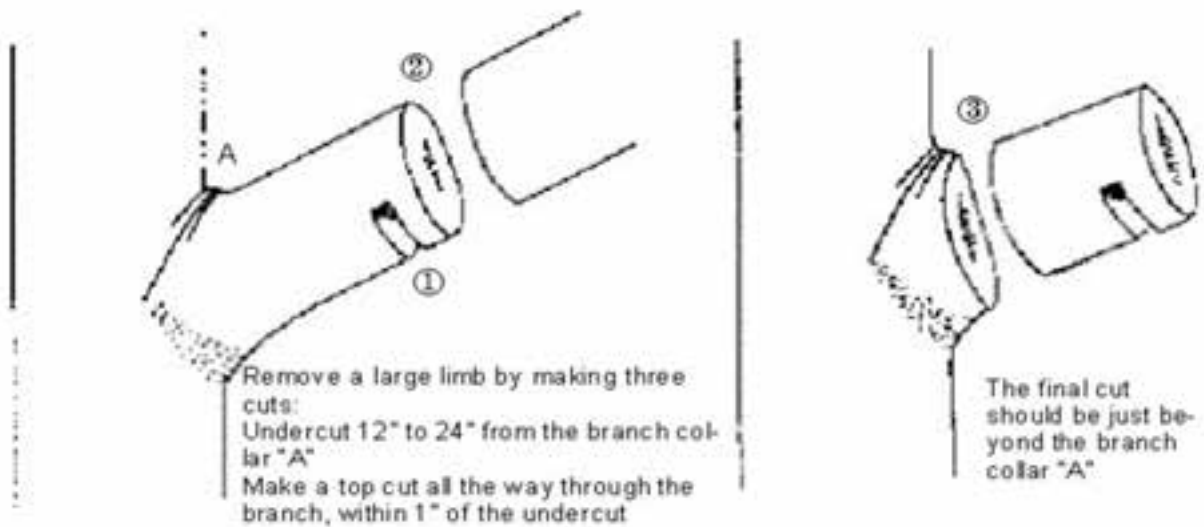
#### A. Pruning

1. FPM Facilities shall be responsible for all pruning of University of Southern California trees. All USC trees shall be pruned on a regular basis using professionally accepted tree pruning standards. These standards are established by the International Society of Arboriculture (ISA), National Arborists Association (NAA), American National Standards Institute (ANSI) Section Z133.1 and ANSI A 300 part 1 Tree, Shrub and Woody Plant Maintenance-Standard Practice, Pruning. All trees shall be pruned in a manner to encourage good development while preserving their overall health, structure and natural appearance. Topping, heading back, lion tailing, or pollarding of campus trees is strictly forbidden. Any variation to these trimming guidelines must be approved prior to work commencing by the University or their consulting arborist.
2. Only trees with broken or dead limbs, and approved as such by the Consulting Arborist shall be pruned. The spacing, balance and attachment of limbs should be evaluated prior to pruning. All pruning cuts should be made per ANSI A-300 standards. Properly pruned shall mean:
  - a) Prune only dead or broken limbs.
  - b) All broken limbs shall be removed to the next sound branch or vigorous bud.
  - c) All dead limbs or dead portions thereof shall be removed to the next live branch or well-placed bud.
  - d) In turf, all limbs less than two (2) feet from the ground shall be removed, unless doing such would cause irreparable damage or leave the tree unbalanced. Multi-trunk trees are exceptions.
  - e) All pruning cuts shall be made at the branch collar, without damaging the collar (see Trimming Standards).
  - f) The primary terminal bud shall not be removed.
3. All newly planted trees shall be placed on a schedule to receive young tree maintenance immediately after completion of a planting program.
4. "Thinning" cuts, or "drop crotching" cuts in mature trees, are the standard pruning technique for all trees. A thinning cut can be defined as the removal of a branch at its point of origin, or the shortening of a branch to a lateral that is large enough to assume the terminal role. Pruning cuts should be made just outside the branch bark ridge and collar. Cutting inside of the branch bark ridge and collar shall be avoided. "Flush cut" is the term used to describe the location of this type of cut. A "flush cut" creates a larger wound and exposes trunk tissues to the possibility of decay. When no collar is visible, the cut angle should parallel the angle formed by the bark branch ridge and trunk.

## USC DESIGN GUIDELINES

- When reducing the length of a large branch, the final cut should be made just beyond the branch bark ridge of the branch being cut. The remaining branch should be no less than 1/3 the diameter of the branch being removed. The remaining branch should also have enough foliage to assume the terminal role. Pruning cuts should be made clean and smooth. Tearing or stripping of the bark shall be avoided at all times. To avoid tearing and stripping of bark, a three-cut process can be performed. The first cut, or undercut, is made approximately a quarter to a third of the distance of the branch being removed. A second cut is then made 6–8 inches beyond the undercut. Once the weight of the branch is removed, the final cut is made just outside the branch bark ridge and collar. This technique will help minimize unnecessary wounding to the tree.

### PRUNING A LIVE BRANCH





## USC DESIGN GUIDELINES

- It is important to train and develop young trees in the first three years they are planted. Properly trained trees will become structurally strong and develop into well-suited trees for their surrounding environment. A well-trained tree will require very little corrective pruning as they mature. A maturing tree should have a sturdy, well-tapered trunk with well-spaced branches that are smaller in diameter than the trunk. If a tree is properly trained and pruned in its first couple of years, less pruning and maintenance will need to be performed on the tree once it's mature.
- Each tree shall be scheduled for training at least once within the first two years after being planted. This trim shall include cleaning out of any dead wood and pruning the tree in a manner as to develop good structure. Also, young trees shall be inspected to ensure stakes and ties are providing adequate support for the tree. Lastly, the tree shall be examined to verify it is getting the correct amount of water.

### Example: Not Pruned When Young



#### **At Planting**

You may receive instructions to the contrary, but little should be done to the tree at this stage. In most cases, it is best to leave all the leaf surface possible to manufacture food that will build a larger root system. It has been found that both roots and top will be larger after one year if left unpruned.

#### **After 3-4 Years**

By the time many transplants are in their new home for 2 to 4 growing seasons, sprouts and suckers may appear. The root suckers protruding near the base sap strength from the tree. The sprouts are disproportionately vigorous and weakly attached to the tree. And look at the broken limb. By now, it has sprouted numerous branches just below the break—too many, in fact.

#### **After 5-7 Years**

The baby is quickly becoming an adult. The results of not making corrections early in life are now quite visible, although some are still not obvious to the untrained eye. To the more careful observer, the form of the future crown is apparent.

#### **15 Years After Planting**

The tree is not only unattractive, but dangerous, especially when the wind is blowing. Lopsided and dense, the tree in full leaf catches the wind like a sail. Also, the narrow branch angles and multiple leaders have resulted in a weak top. The broken branch not only attracted insects, but may soon break off under the weight of too many sprouts. Decay has entered the trunk where the little bent branch tore off many years ago and a jagged stub protrudes just above it. The tree is an accident waiting to happen. It is becoming more of a liability than an asset for the property.

## USC DESIGN GUIDELINES

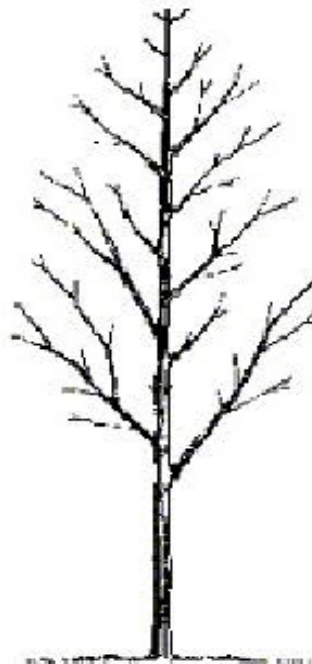
Example:  
Pruned When Young



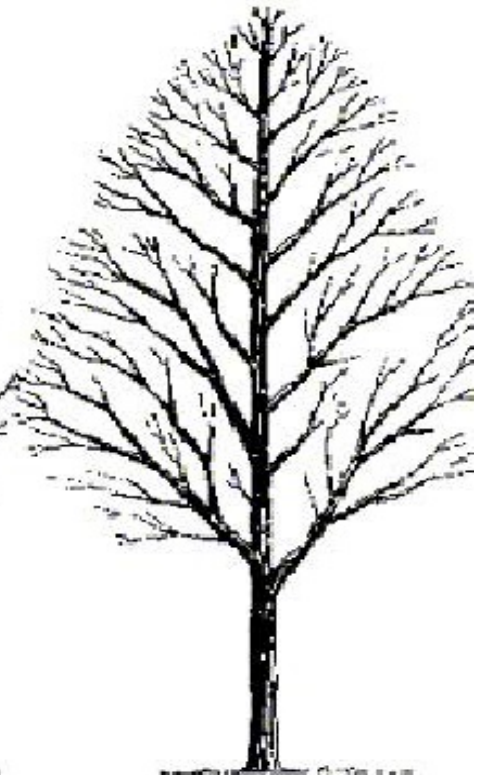
**At Planting**  
At planting there was a broken branch and a branch that was competing with the leader. Both were pruned close to the trunk. Another, swollen from the sting of an insect laying eggs (a gall), was snipped off. Otherwise, all branches were left intact to provide maximum leaf surface to manufacture food during the first year of life in its new home.



**After 3-4 Years**  
By now root growth should be well on its way to anchoring the transplant and expanding to the size necessary to nourish the growing branches. The root suckers and sprouts in the crown are cut off. Other excessive branches are thinned to reduce competition for light, water and nutrients, and a co-dominant leader is removed. A few of the lowest limbs are also removed, but others are temporarily left to help the trunk develop more taper and strength. Growth is far enough along to reveal problems developing such as branches that rub or are growing in an undesirable direction. Narrow angles are also eliminated.



**After 5-7 Years**  
Now is the time to make a good tree even better. Lower limbs are pruned off to "raise" the bottom of the crown well out of the way of human heads. The lowest limbs are now the permanent lowest limbs. *An important fact is recognized here. Branches do not move upward as a tree grows taller. The center of a branch at 5 feet will always be at 5 feet.* Higher up, a few overzealous branches are cut back so they do not protrude beyond the graceful outline of the crown. A branch here and there is removed for more even spacing—but basically the job of sculpturing the tree is now complete.



**15 Years After Planting**  
This tree survived a major wind storm one summer day. While many other trees suffered split tops and broken limbs, this one stood strong and firm. Proper pruning gave strength to the branches and allowed the wind to pass harmlessly through the thinned crown. Early each spring the tree gets scrutinized and dead or damaged limbs are cut off using proper pruning methods.

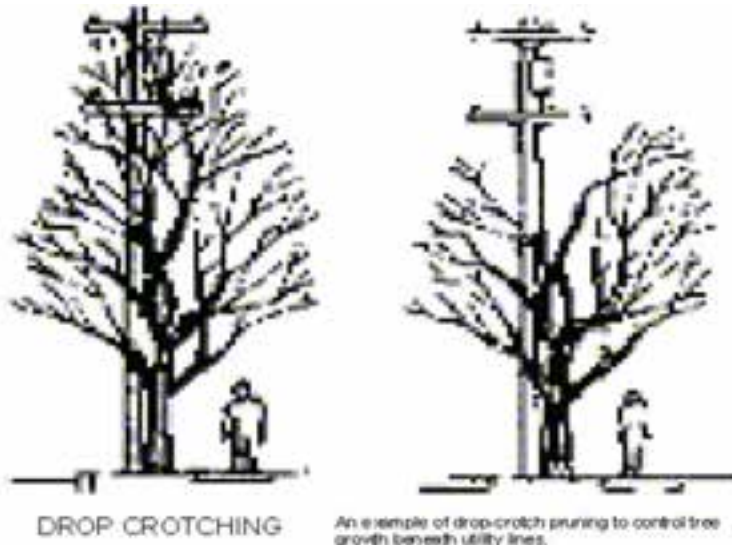
\* Illustration Courtesy of National Arbor Day Foundation

## USC DESIGN GUIDELINES

8. As trees mature the need for structural pruning should decrease. The focus should then be on maintaining tree structure, form, health, and appearance. One of the following three trim methods shall be used to accomplish this.
  - a) Crown Cleaning is the removal of dead, dying, broken, diseased, crossing, weakly attached, and low-vigor branches from a tree's crown. It also includes the elimination of water sprouts, sucker growth, and foreign materials from the entire tree. Crown cleaning shall be completed on an as needed basis.
  - b) Crown Restoration improves structure and appearance of trees that have sprouted vigorously after being broken, topped, or severely pruned using heading cuts. One to three sprouts, on main branch stubs, should be selected to form a natural appearing crown. More vigorous sprouts may need to be thinned or cut to a lateral to control length growth or ensure adequate attachment for the size of the sprout. Crown restoration may require several prunings over a number of years. Crown restoration shall be done as needed. It will be based upon the specific condition and circumstances surrounding the tree.
  - c) Crown Thinning is the selective removal of branches to increase light penetration and air movement through the crown. Thinning opens up the tree, reduces weight on heavy limbs, distributes growth and vigor throughout the tree, and helps retain the tree's natural form.  
As a rule, no more than 20% to 30 % of live growth should be removed when a trimming is performed. In sensitive or slower growing trees, no more than 10% of live growth shall be removed. Trees always need to be trimmed to their natural form. Well-shaped inner lateral branches with foliage shall be retained through this process. Thinning trees and branches makes mechanical stress more evenly distributed along the branch and throughout the tree.
  - d) Palm trees shall be pruned by removing all dead and live fronds so that the remaining healthy fronds are existing at an upward 80-degree angle in relation to a horizontal plane at the head of the palm tree. All frond sheaths shall be removed along the entire length of the tree.
9. Pruning frequency is important to a tree's health. Pruning cycles are determined by safety, health, and aesthetics. Other factors should be based upon species growth rate and pattern, susceptibility to breakage, and environmental factors. The campus has been split into three trimming districts. In general, each tree will be put on a three year trim cycle. There will be exceptions made for certain tree species that may need to be trimmed more frequently. Examples of these trees are Palms and Corals. These trees will be put on an annual or bi-annual trim cycle.  
Trees such as Pines may need to go to a four or five year cycle. This will be determined at each three year cycle. If a tree is scheduled to be trimmed, but does not need it at the time, it will be deferred to the following year. Necessary maintenance required on individual trees shall have priority over the regular

## USC DESIGN GUIDELINES

- pruning cycle. This includes trees infested with insects or diseases. If a tree can become stressed due to trimming at its normal cycle, it will be skipped and trimmed at a better time for it to cope with stress.
10. Crown raising is the appropriate technique for clearance standards. This process involves the removal of lower branches in order to provide clearance for vehicles, pedestrians, and bicyclists. Remove only those branches needed to achieve the proper height clearance standard. All pruning cuts must be made back to the nearest lateral branch above the required height.
  11. Young trees should be maintained to keep at least one half (1/2) of the foliage on the branches that originate on the lower two-thirds of the tree. This helps establish a significant and well-tapered trunk and also distributes stress within the tree.
  12. The following are height clearance specifications:
    - a) Sidewalks/Pathways Limbs shall be raised to a minimum of seven feet and to a maximum of ten feet from grade to wood. Where no sidewalk exists, limbs may be retained below this minimum height standard as long as they conform to the natural shape of the species. If limbs do not interfere with traffic, they can be retained below this minimum height standard.
    - b) Streets/Parking Lots Limbs shall be raised gradually from eight feet at the curb to thirteen feet over traffic lanes from grade to wood. The limb should give an appearance of an arch rather than an angle.
  13. Clearance for lights or signs shall be achieved through “windowing” through the foliage of the tree. Severely raising or reducing the crown should be avoided whenever possible. Only branches and foliage blocking visibility shall be removed. All branches shall be removed to the nearest lateral found away from the structure to be cleared.
  14. Anyone working in or around high voltage wiring must be trained as a line-clearance tree worker. All line-clearance work shall adhere to utility pruning standards established by the International Society of Arboriculture and the Utility Arborists Association.



## USC DESIGN GUIDELINES

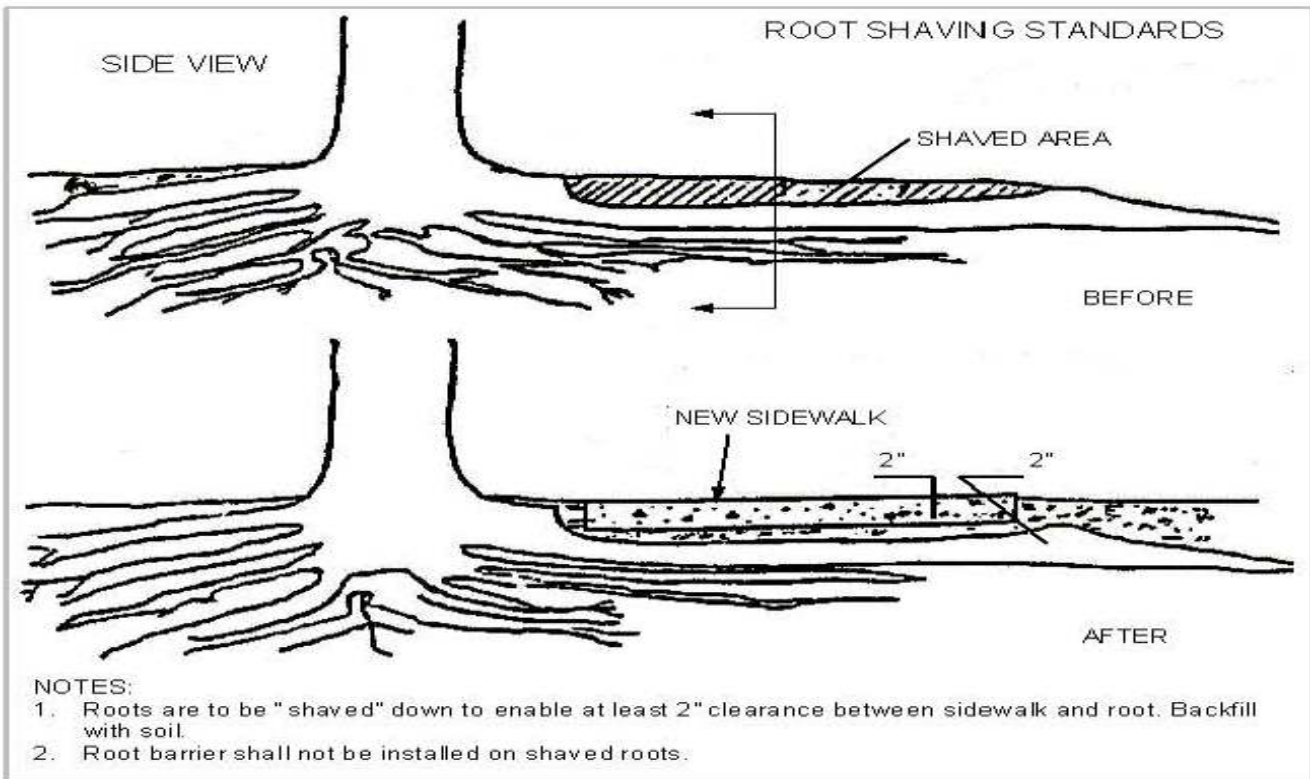
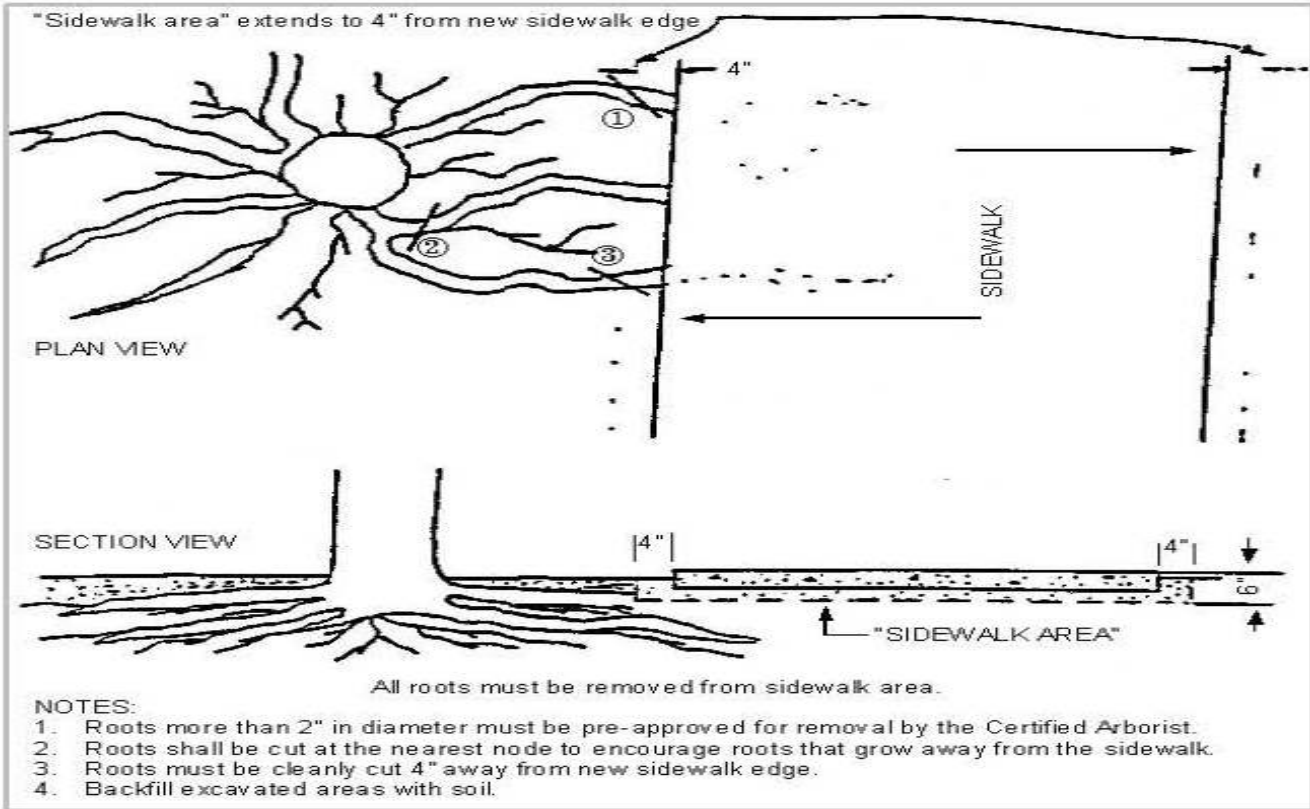
15. Lateral or directional pruning is the best form of tree pruning under utility lines. It preserves the tree's health and is less costly in the long run. Directional pruning is the removal of a branch to the trunk or a significant lateral branch growing away from the conductor. Heading cuts, or pollarding, encourages vigorous, weak sprouting. Pollarding increases the frequency of pruning cycles and the cost of maintenance. Where possible, trees should be allowed to attain normal height, with crown maturing away from high voltage conductors. To achieve clearance, pruning should be restricted to removal of branches at crotches within the tree's crown. Cuts should be restricted as much as possible to achieve the required clearance.
16. Pruning cuts shall be determined by anatomy, structure and branching habit. Under no circumstance are limbs to be arbitrarily removed, based on a pre-established clearing limit.
17. "Roundover" or "hedging" cuts are not acceptable pruning practices. These types of cuts cause rapid, vigorous growth, resulting in the need to increase the frequency of pruning. Both roundover and topping of trees for line clearance is prohibited.
18. Climbing and pruning practices shall not injure the tree except for the pruning cuts. Any climbing spurs or gaffs will not be allowed when pruning a tree, unless the branches are more than throw-line distance apart. In these cases, the spurs should be removed once the climber is tied in. Spurs are allowed only to rescue an injured climber or in tree removal.
19. Rope injuries to thin barked trees from loading out heavy limbs will be avoided by installing a block in the tree to carry the load. This technique should also be used to reduce injury to a crotch from the climber's line.
20. Because the root system of a tree is the most important physiological component, extreme care and precaution must be taken when pruning the roots. Roots are the main source of water and mineral absorption for the tree. They provide anchorage and stability as well as act as storage area for food. Proper pruning on roots is as important as pruning a tree's crown.
21. Removing roots shall be avoided whenever possible. If utilities or subsurface structure need to be installed, every effort must be made to trench and dig outside of the tree's dripline. Some examples are irrigation lines, wall footings, or electrical conduit. When it is necessary to encroach into the dripline, every effort must be made to tunnel under or through the tree's root system with a minimal amount of pruning. This is preferred over trenching across the tree's roots. Roots over 2 inches in diameter must be pre-approved for removal by the Associate Director of Landscape and Grounds.
22. To remove roots for hardscape repair or replacement, two methods shall be utilized. The two methods are Selective Root Pruning and Root Shaving. The following are details and specifications for root pruning and shaving.
  - a) Selective Root Pruning is the removal of specific roots which are directly interfering with a work area. When selectively pruning roots, care must be taken to retain as much of the root's surface as possible. This includes

## USC DESIGN GUIDELINES

sufficient buttress root dispersal around the base of the tree. No more than 1/4 of the tree's root system shall be removed. Roots shall be cut back at least four inches from the edge of the new hardscape to the nearest node. Cuts must be made clear and smooth, avoiding tearing and crushing of the root.

- b) Root Shaving is the removal of a small portion of a nonessential buttress root or for at least two inches of clearance between the root and the new hardscape. No more than 1/3 of the root's diameter will be shaved off. All shaving will be clean and smooth, avoiding any crushing or tearing of the remaining root. To avoid moisture loss and minimize drying out, the soil needs to be backfilled immediately following any root pruning or shaving activity.

## USC DESIGN GUIDELINES



## **USC DESIGN GUIDELINES**

23. Any contractor performing tree work shall be required to employ a Certified Arborist, as accredited by the International Society of Arboriculture (ISA) They must also have a State contractor's license for tree work and provide worker's compensation benefits to their employees. They should also have the appropriate liability insurance. Contractors must adhere to all University of Southern California standards and specifications.
24. The work area is to be left in a condition equal to or better than when it existed prior to work commencement. All lawn areas shall be raked, all streets and sidewalks shall be swept and all brush, branches, rocks or other debris shall be removed from the site. Any turf or shrubs damaged due to tree work must be replaced with same size or larger plants.

**END OF DOCUMENT**



# USC DESIGN GUIDELINES

## 32 1300 RIGID PAVING

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. For purpose of this guideline, this section pertains to paving both campus “typical” and “enhanced”.
- B. Quality Assurance requirements beyond standard 1 year warranty: None

### 3. PRODUCT REQUIREMENTS

- A. “Typical” Paving: (example – Childs Way)
  - 1. Concrete:
    - a) Color: Natural Gray with Topcast #5 finish
    - b) 3/16” x 1” deep sawcut joints
  - 2. Brick Bands
    - a) Size: 24 ½” wide
    - b) Manufacturer: Pacific Clay ‘Bear Path’ pavers
    - c) Brick thickness: 2 1/3” thick
    - d) Color: Red-Flashed



- B. “Enhanced” Paving: (example – Hahn Plaza)
  - 1. Bricks:
    - a) Manufacturer: Pacific Clay “Bear Path” pavers
    - b) Thickness: 2 ¼” thick
    - c) Colors:
      - 1) Bands color – ‘Red Flashed’
      - 2) Fields color – “Pueblo’
      - 3) Diagonals color – “Burgundy”
    - d) Brick Bands
      - 1) Size: 24 ½” wide
      - 2) Manufacturer: Pacific Clay ‘Bear Path’ pavers



## **USC DESIGN GUIDELINES**

- 3) Brick thickness: 2 1/3" thick
  - 4) Color: Red-Flashed
- C. In-Between Pavers:
1. Allowed: Mortar for bonding purposes
  2. Disallowed: Sand, beach sand, polymeric sand

### **4. INSTALLATION REQUIREMENTS**

- A. Required:
1. Install per manufacturer requirements

### **5. EVALUATION or COMMISSIONING – NOT USED**

**END OF DOCUMENT**

# FACILITY DESIGN GUIDELINES

## 32 8000 IRRIGATION

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X	X	

### 2. PROCEDURAL REQUIREMENTS

- A. General Requirements
  1. The irrigation plan may be designed by a licensed landscape architect. The final irrigation plan shall be signed by a licensed landscape architect or architect prior to submittal for approval.
  2. Include point of connection, water supply type (potable, graywater, cistern, recycled).
  3. Include all parts and their make and model, including but not limited to: pressure regulators, valves, backflow prevention devices, filters, piping and piping depth, pressurized main lines and lateral lines, sprinkler heads showing head-to-head coverage, drip irrigation components and drip irrigation layout.
  4. Include a static pressure reading for the irrigation system measured from the point of connection.
  5. Include irrigation details, with applicable detailed drawings, and specifications
  6. Irrigation design shall accommodate hydrozones accordingly. For example; separate zones may be required for trees, shrubs, flowers, shady or sunny areas, drip irrigation and/ or sprinklers.
  7. Submitted plans must include the following notation:
    - a) “the irrigation system must comply with all local, state, and federal laws and regulations”.
    - b) “the irrigation designer or landscape architect or landscape designer shall perform one or more site observations during system installation to check for adherence to the design, including the proper installation of the backflow prevention assembly, main line, laterals, valves, sprinkler heads, drip irrigation equipment, control wires, controllers, and sensors and should assure that the intent of the irrigation design has been preserved”.
- B. IRRIGATION DESIGN GUIDELINES
  1. Available static pressure downstream of backflow prevention device: **50 psi. RCV** demand not to exceed 80% of system capacity.
  2. Install drip system in planters and ground cover areas.
  3. Sprinkler for turf areas must have head to head overlap coverage.

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4. Provide 3 extra direct burial 14 gauge wire at every mainline terminus.
5. Provide quick coupler valve every 100ft. of mainline.
6. Provide 2 pieces of 8.5 X 11 color coded controller chart.
7. Provide 2 union joints for every remote control valve, one upstream and one downstream of the valve.
8. Use a dedicated point of connection with master valve and flowmeter for every controller.
9. Install appropriate size PVC pipe for sleeves under hardscape, cover ends of sleeve w/duct tape.
10. Mainline must be buried to a minimum depth of 18".
11. Irrigation wires must be buried to minimum depth of 18".
12. Lateral line must be buried to minimum depth of 12".
13. Any instances where an existing controller is to be used, and or relocated, requires a radio test by CALSENSE to insure communication with USC irrigation central control.
14. Design of irrigation system shall be based on hydrozones and plant requirements. Areas with differing exposures and groups of plants with different water needs shall not be grouped into the same zones.
15. Irrigation stations with low precipitation rate, multi-stream spray heads must not be designed for maximum flow rate. Design to only 70% flow rate capacity.

### C. IRRIGATION SYSTEM REQUIREMENTS

1. Landscape areas may be watered by hand, manual or automatic irrigation systems. Where permanent irrigation systems are not required, hoses shall be equipped with an automated, shut off nozzle and a hose bib vacuum breaker.
2. Irrigation systems must be designed and installed in such a manner that a precipitation rate of .75 inches per hour is not exceeded in any portion of the landscape, providing slope is  $\leq 30$  degrees.
3. Sprinklers and bubblers must be on separate valves.
4. Design landscape and irrigation systems in parkways according to all local, state, and federal laws and regulations. Installation of an irrigation system within a parkway cannot result in the damage of the roots of and existing landscape trees.
5. Low head drainage is prohibited. Anti-drain valves or check valves in sprinkler heads are required as necessary to prevent low head drainage.
6. Specify pressure regulation to insure that the dynamic pressure at each emission device is within the manufacturer's recommended pressure range for optimal performance.
7. Pressure regulation may include a single master filter and/or master pressure regulator may be used for the entire system, located after the backflow device and /or master valve. In this case, if the system does not include a master valve, heavy-duty grade filters and pressure regulators that can tolerate constant pressurization must be used.

### D. SPRINKLER IRRIGATION REQUIREMENTS

1. Sprinklers shall have a minimum operation lower quarter distribution uniformity of 70%.
2. Irrigation shall not run off nor overspray onto impermeable surfaces including but not limited to buildings, fencing, property line, public right-of-way.
3. Sprinkler heads on the same valve shall have matched precipitation rates.
4. Spray heads with or without multi-stream, multi-trajectory rotating nozzles, shall have built-in pressure regulation in the body or stem.

## FACILITY DESIGN GUIDELINES

5. Sprinkler heads shall have swing joints or other riser-protection components.
6. Sprinkler heads must have a minimum of head-to-head coverage (minimum of 50% diameter). Wind derating, if used, should be based on wind criteria for the time period that the system is normally operated.

### E. AS BUILT PLANS

1. Provide a complete set of As-Built plans for the property owner.
2. Materials List is provided in following pages specifying approved materials for project.
3. Diagram is provided for approved installation for CalSense approved flow meter

## 3. PRODUCT REQUIREMENTS

### A. WATER SUPPLY & METER

1. Manual shut-off valves (such as a gate valve, ball valve, or butterfly valve) shall be required, as close as possible to the point of connection of the water supply, to minimize water loss in case of an emergency (such as a main line break) or routine repair.
2. Cross-Connection Prevention (Backflow Prevention) as required by USC.

### B. PIPES

1. Specify main and lateral pipe sizes that will result in the velocity of water moving through these pipes at a rate not exceeding 7.5 feet per second.
2. Use schedule 40 or Class 315 solvent weld-type PVC pipe for mains, below grade laterals, or piping under roadways. Class 125 pipe is not permitted.
3. IPS Flexible PVC Pipe may be substituted for rigid PVC pipe below grade (in lateral lines only) to avoid underground obstructions encountered during trenching or tunneling.
4. Above grade pipes use Schedule 80 or metal piping.
5. Pipe laid in the same trench must be laid side-by-side and not overlapped. Provide 3 inch vertical and horizontal clearance between irrigation lines and 6 inch clearance between lines of other work. Do not install parallel lines directly over any other line.
6. PVC fittings must be of the same chemical compounded as pipe on which they are installed.
7. PVC cement must be of an appropriate chemical compound for the pipe on which it is used.
8. Trench or tunnel depth must be sufficient to obtain a minimum depth of cover over the installed pipe and control wire which conforms to the following dimensions. Where pipe and or conduit are placed below paving or hardscape the minimum burial depths are:

Pressure Lines $\leq$ inches in landscaping	12"
Pressure Lines $>2$ inches in landscaping	18"
Pressure Lines under non-vehicular paving	18"
Pressure Lines under vehicular paving	24"

## FACILITY DESIGN GUIDELINES

Non-pressure Lines $\leq$ inches in landscaping	8"
Non-pressure Lines $>$ inches in landscaping	12"
Non-pressure Lines under non-vehicular paving	12"
Non-pressure Lines under vehicular paving	18"
Conduit in landscaping	12"
Conduit under non-vehicular paving	18"
Conduit under vehicular paving	24"

### C. AUTOMATIC IRRIGATION CONTROLLER

1. Weather based irrigation controllers (WBIC) are required. Only Smart Water Application Technologies tested and published WBICs are permitted i.e., CALSENSE CS3-XX-SI/CS3-LR/LR/STUBBY/FM-XX

## 4. INSTALLATION REQUIREMENTS

### A. Required:

1. Contact Digalert prior to beginning installation, to locate any underground utilities. This is a State Law. Install cannot proceed until all necessary marks are made and approval has been given.
2. Install the irrigation system according to the approved design, specifications, and manufacturer's published performance standards.
3. An open-trench inspection by USC Staff is required prior to covering below grade pipes, laterals and mains.
4. Installer shall test the irrigation system to verify that it meets the approved design and specifications.
5. Installer must initially program the WBIC (controller).
6. Final inspection by USC Staff is required and CalSense representative to ensure that the system was built to approved plans and specifications, including CalSense specifications.
7. Provide all keys, tools, warranties and operating instructions for all equipment as part of project close out.

## 5. EVALUATION or COMMISSIONING – NOT USED

## FACILITY DESIGN GUIDELINES

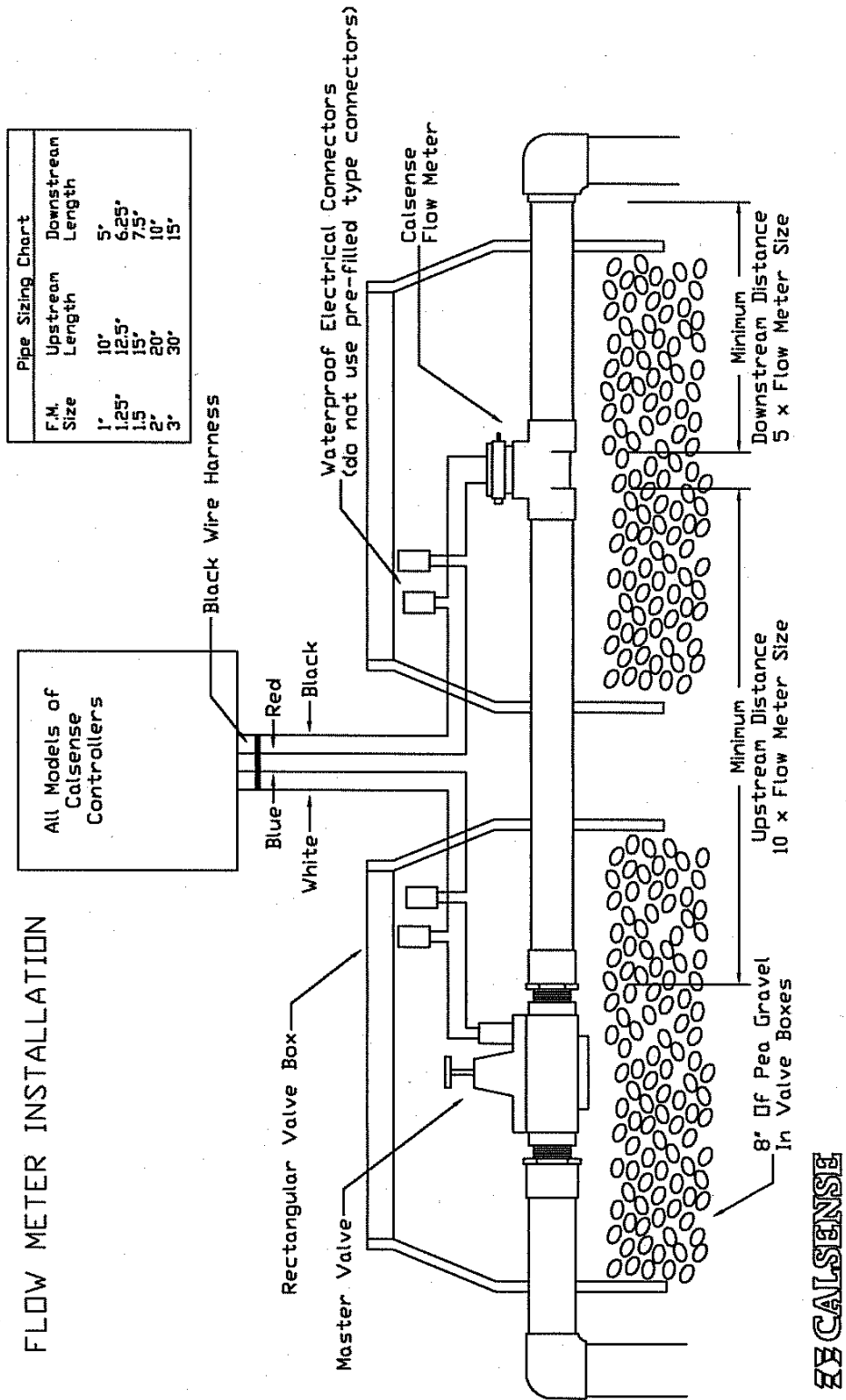
### EXHIBIT A:

#### MATERIAL LIST

<u>Item</u>	<u>Description</u>	<u>Manufacturer</u>	<u>Model No.</u>
1	Backflow preventer	Watts	909 QTPC
2	Remote control valve	Rainbird	PESB
3	Master valve	Superior	3100
4	Flow meter	Calsense	FM # mainline size
5	Irrigation Controller	Calsense	CS3-XX-S1/CS3-LR/LR/ Stubby/FM-XX
	Stainless top open pedestal	Calsense	SSE-R
6	Sprinklers	Rainbird	1800, 5000 plus, 3500, 6500 Falcom w/ MPR nozzles
7	PVC Lateral pipe	All sizes	Schedule 40
8	PVC Mainline pipe	2-1/2" or less	Schedule 20
		3" or more	Class 315
9	Dry Splice wire connectors	Spears (pre filled)	DS 400
10	RCV valve box	Carson	3412 w/ 1419-4B cover
11	QCV	Rainbird	33-LRC
12	QCV valve box	Carson	910-10 w/ 910-4B cover
13	Swing Joint	Do not use pre-fabricated; use field assembly PVC street ell.	
14	Brass ball valve		
15	Irrigation control wire	14 AWG direct burial wire	

# FACILITY DESIGN GUIDELINES

EXHIBIT B:





# FACILITY DESIGN GUIDELINES

END OF DOCUMENT

# USC DESIGN GUIDELINES

## 33 0000 ORDER OF INVERTS

### 1. OVERVIEW

#### A. University Park Campus (UPC)

- I. Purpose: USC preferences and requirements are indicated in this document. For other related requirements, refer to Section 33 10 00, 33 17 00, 33 30 00, 33 40 00, 33 60 00 AND 33 70 00.
- II. Existing Campus Utility Infrastructure Maps
  - 1) Private Utilities: Combined Domestic/Fire Water, Reclaimed Water, Steam and Condensate Return, Chilled Water Supply and Return, Electrical and IT
    - a) Request recent maps from University Project Manager
  - 2) Public Utilities: Sanitary Sewer, Storm Drain and Gas
    - a) Request recent maps from University Project Manager and research available record drawings with public utility purveyor.

#### B. Other USC facilities Including Health Science Campus (except Catalina campus)

- I. Purpose: USC preferences and requirements are indicated in this document. For other related requirements, refer to Section 33 10 00, 33 17 00, 33 30 00, 33 40 00, 33 60 00 AND 33 70 00.
- II. Existing Campus Utility Infrastructure Maps
  - 1) Private Utilities: Steam and Condensate Return, Chilled Water Supply and Return, Electrical and IT
    - a) Request recent maps from University Project Manager
  - 2) Public Utilities: Water, Sanitary Sewer, Storm Drain, Electrical, IT and Gas
    - a) Request recent maps from University Project Manager and research available record drawings with public utility purveyor.

- C. The following table summarizes the types of particular requirements identified within this section for all USC Campuses unless noted otherwise:

## USC DESIGN GUIDELINES

<b>Order of Inverts++</b> (Refer to Order of Inverts Sketch Below)				
<b>Utility</b>	<b>Horizontal Criteria+</b>	<b>Vertical Criteria+</b>	<b>Trench Backfill** and Compaction Criteria</b>	<b>Additional Criteria</b>
Electrical	Min. 12 inch separation between electrical and IT.	Low Voltage: 24" High Voltage: 36"	Native soil, 6 inch layers, 95% compacted OR Type 1 (See footnote).	
Security	Min. 12 inch separation between security and IT.	24 – 30 inches	Native soil, 6 inch layers, 95% compacted OR Type 1 (See footnote).	
IT	Min. 12 inch separation between electrical and IT.	24 – 30 inches	Native soil, 6 inch layers, 95% compacted OR Type 1 (See footnote).	
Gas	Coordinate with Utility Purveyor.	30 – 36 inches	Native soil, 6 inch layers, 95% compacted	Campus gas is public utility with easements. Coordinate with public utility purveyor and FPM Facilities. Cannot run under structures.
Combined Domestic/Fire Water*	Min. 10 feet separation between reclaimed water and sanitary sewer*.	Min. 36 inches  Lay water mains over sanitary sewers to provide vertical separation minimum 3 feet.  Minimum 12 inches clearance above reclaimed water.	Refer to flexible pipe bedding and backfill detail. Trench backfill may be substituted with Type 1 (see footnote)	

## USC DESIGN GUIDELINES

Reclaimed Water*	Min. 10 feet separation from combined domestic/fire water*.	Min. 36 inches  Minimum 12 inches clearance below combined domestic/fire water.	Refer to flexible pipe bedding and backfill detail. Trench backfill may be substituted with Type 1 (see footnote)	Where additional measures i.e. sleeving required, coordinate with appropriate governing agency.
Chilled Water Supply & Return	Min. 6-12 inches from other utilities	Min. 36 inches with preferred bottom of trench depth not to exceed 5 ft.	Native soil, 6 inch layers, 95% compacted OR Type 1 (see footnote)	Horizontal and vertical alignment to account for utility insulation.
Heating Hot Water Supply and Return Piping	Min. 12 inches from other utilities	Min. 36 inches with preferred bottom of trench depth not to exceed 5 ft.	Native soil, 6 inch layers, 95% compacted	Horizontal and vertical alignment to account for utility insulation.
Steam & Condensate Return	Min. 12 inches from other utilities	Min. 36 inches with preferred bottom of trench depth not to exceed 5 ft.	Native soil, 6 inch layers, 95% compacted	Horizontal and vertical alignment to account for utility insulation.
Storm Drain	Coordinate and account for existing utilities.	Laterals to be min. 12 inches in landscape areas and min. 18 inches in paved areas.	Refer to flexible pipe bedding and backfill detail where applicable. In other cases, refer to section 33 40 00.	Coordinate with utility purveyor and FPM Facilities.
Sanitary Sewer	Min. 10 feet separation from combined domestic/fire water.	Laterals to be min. 12 inches in landscape areas and min. 18 inches in paved areas.  Lay sanitary mains under water main to provide vertical separation minimum 3 feet.	Refer to flexible pipe bedding and backfill detail where applicable. In other cases, refer to section 33 30 00.	Coordinate with utility purveyor and FPM Facilities.

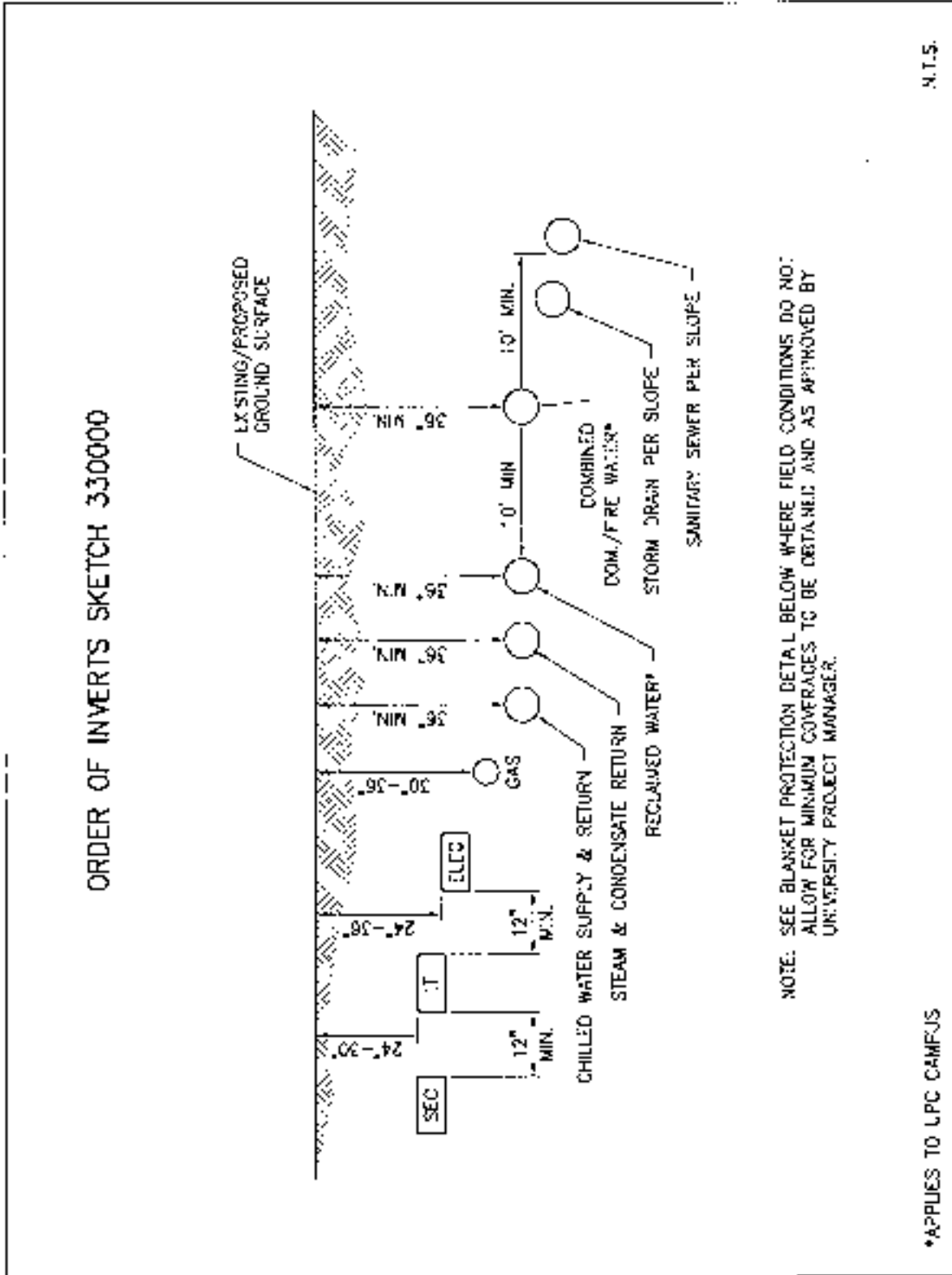
\* Applies to UPC Campus

\*\* Initial Backfill to be 6-12 inches native soils.

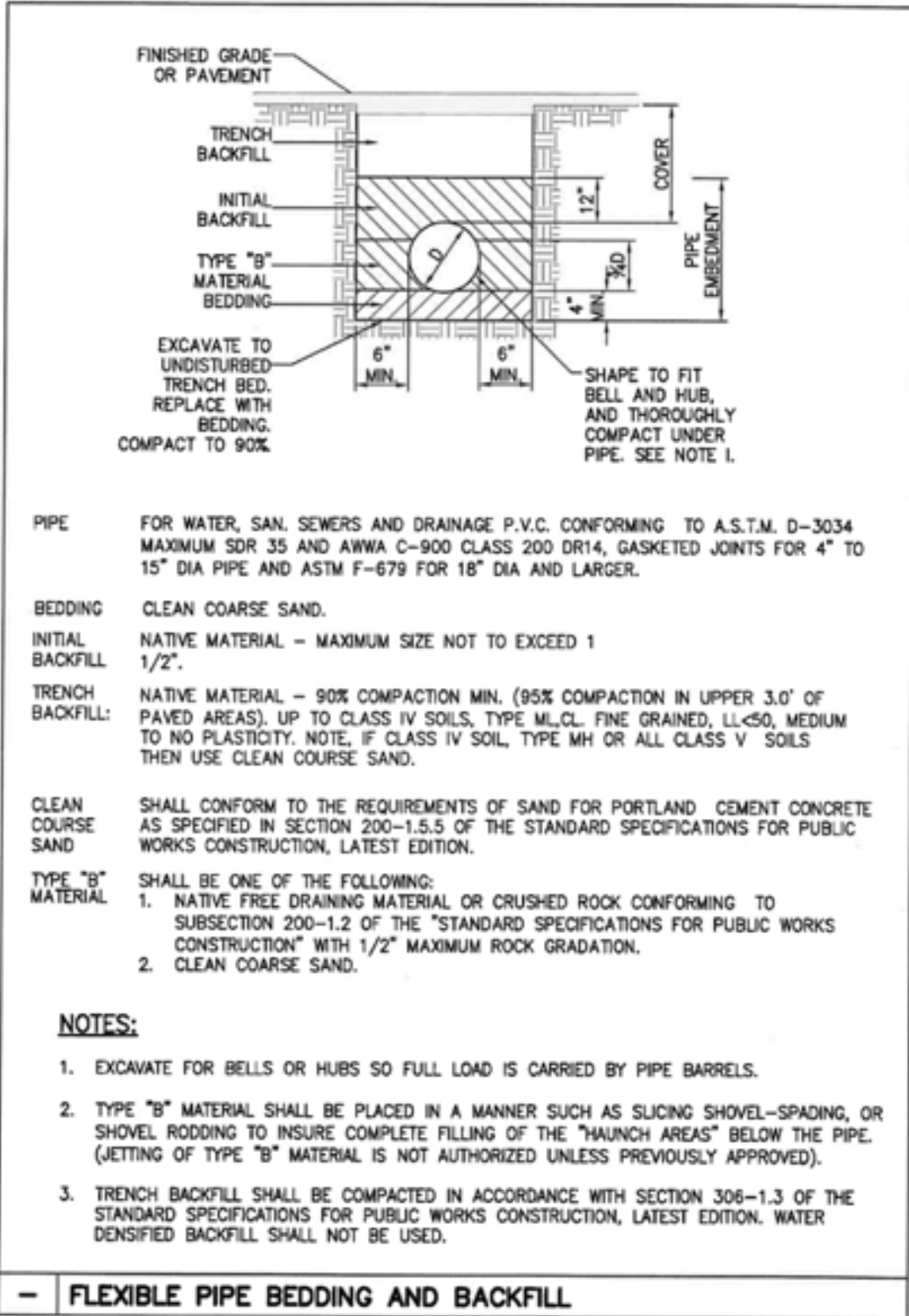
## USC DESIGN GUIDELINES

- + *Horizontal and vertical clearances are from/to outside diameter of adjacent utilities.*  
*Vertical Depths are from Existing/Proposed Ground Surface to the top of pipe soffit.*
- ++ *Confirm the location of public utility easements*

Type 1: Place and compact initial trench backfill of satisfactory soil. 1 Sack Slurry mix (not to exceed) to maximum 18" below final grade elevation under hardscape areas and maximum 24" below final grade in landscape areas (see flexible pipe backfill detail where applicable). Contractor to coordinate with USC project manager to determine where and when appropriate.



## USC DESIGN GUIDELINES



**PIPE** FOR WATER, SAN. SEWERS AND DRAINAGE P.V.C. CONFORMING TO A.S.T.M. D-3034 MAXIMUM SDR 35 AND AWWA C-900 CLASS 200 DR14, GASKETED JOINTS FOR 4" TO 15" DIA PIPE AND ASTM F-679 FOR 18" DIA AND LARGER.

**BEDDING** CLEAN COARSE SAND.

**INITIAL BACKFILL** NATIVE MATERIAL - MAXIMUM SIZE NOT TO EXCEED 1 1/2".

**TRENCH BACKFILL:** NATIVE MATERIAL - 90% COMPACTION MIN. (95% COMPACTION IN UPPER 3.0' OF PAVED AREAS). UP TO CLASS IV SOILS, TYPE ML,CL. FINE GRAINED, LL<50, MEDIUM TO NO PLASTICITY. NOTE, IF CLASS IV SOIL, TYPE MH OR ALL CLASS V SOILS THEN USE CLEAN COURSE SAND.

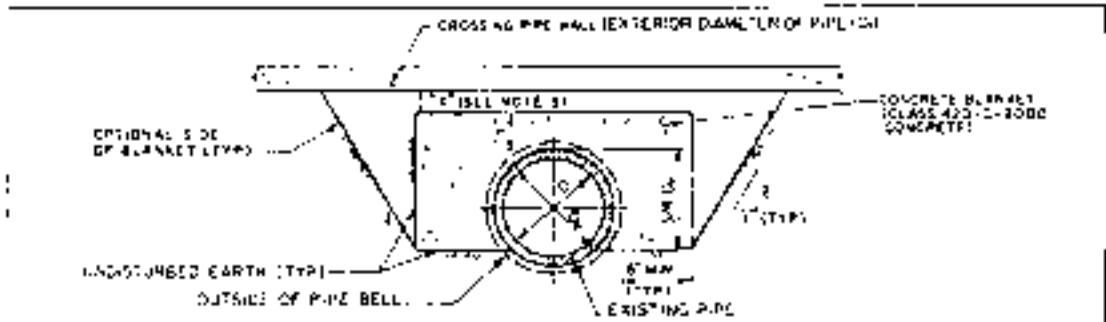
**CLEAN COURSE SAND** SHALL CONFORM TO THE REQUIREMENTS OF SAND FOR PORTLAND CEMENT CONCRETE AS SPECIFIED IN SECTION 200-1.5.5 OF THE STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION, LATEST EDITION.

**TYPE "B" MATERIAL** SHALL BE ONE OF THE FOLLOWING:  
 1. NATIVE FREE DRAINING MATERIAL OR CRUSHED ROCK CONFORMING TO SUBSECTION 200-1.2 OF THE "STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION" WITH 1/2" MAXIMUM ROCK GRADATION.  
 2. CLEAN COARSE SAND.

**NOTES:**

1. EXCAVATE FOR BELLS OR HUBS SO FULL LOAD IS CARRIED BY PIPE BARRELS.
2. TYPE "B" MATERIAL SHALL BE PLACED IN A MANNER SUCH AS SLICING SHOVEL-SPADING, OR SHOVEL RODDING TO INSURE COMPLETE FILLING OF THE "HAUNCH AREAS" BELOW THE PIPE. (JETTING OF TYPE "B" MATERIAL IS NOT AUTHORIZED UNLESS PREVIOUSLY APPROVED).
3. TRENCH BACKFILL SHALL BE COMPACTED IN ACCORDANCE WITH SECTION 306-1.3 OF THE STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION, LATEST EDITION. WATER DENSIFIED BACKFILL SHALL NOT BE USED.

# USC DESIGN GUIDELINES

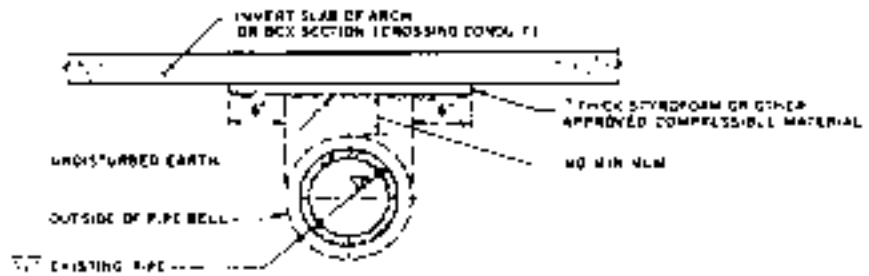


## CONCRETE BLANKET

(FOR EXISTING PIPES CROSSED OVER BY A NEW PIPE)

### NOTES FOR CONCRETE BLANKET

1. CONCRETE BLANKET IS REQUIRED WHEN THE CLEARANCE BETWEEN THE TOP OF THE EXISTING PIPE AND THE BOTTOM OF THE CROSSING PIPE IS LESS THAN 18 INCHES.
2. IF THE CLEARANCE IS BETWEEN 18 INCHES AND 24 INCHES, THE CONCRETE SHALL BE PLACED BETWEEN THE PIPES AND AROUND THE SIDES OF THE CROSSING PIPE UP TO A LEVEL 3 INCHES ABOVE THE EXISTING PIPE OR AS REQUIRED BY NOTE 3 BELOW, WHICHEVER IS GREATER.
3. PROVIDE 4 INCHES MINIMUM TO PROVIDE BEDDING MATERIAL FOR THE CROSSING CONDUIT WHEN "X" IS LESS THAN THIS MINIMUM. THE ENTIRE TOP SURFACE OF THE BLANKET SHALL EXTEND TO A LEVEL OF 6 INCHES ABOVE THE BOTTOM OF THE CROSSING PIPE.
4. THE BLANKET SHALL EXTEND LONGITUDINALLY BEYOND THE TRENCH EXCAVATION TO ONE FOOT BEFORE THE FIRST PIPE JOINTS, EXCEPT THAT THE BLANKET NEED NOT EXTEND MORE THAN 4 FEET BEYOND EACH SIDE OF THE TRENCH.



## COMPRESSIBLE BLANKET

(FOR EXISTING PIPES CROSSED OVER BY A NEW BOX OR ARCH)

### NOTES FOR COMPRESSIBLE BLANKET

1. COMPRESSIBLE BLANKET IS REQUIRED WHEN THE CLEARANCE BETWEEN THE TOP OF THE EXISTING PIPE AND THE BOTTOM OF THE CROSSING CONDUIT (BOX OR ARCH) IS LESS THAN 18 INCHES.
2. THE BLANKET SHALL EXTEND LONGITUDINALLY FOR THE FULL CROSSING CONDUIT TRENCH WIDTH.

DEPARTMENT OF PUBLIC WORKS		CITY OF LOS ANGELES
BLANKET PROTECTION FOR PIPES		STANDARD PLAN S-255-1
DRAWN BY: <i>[Signature]</i> CHECKED BY: <i>[Signature]</i> DATE: 1/30/2020	PROJECT: <i>[Blank]</i> LOCATION: <i>[Blank]</i> CONTRACT NO.: <i>[Blank]</i> SHEET NO.: <i>[Blank]</i>	DESIGNED BY: <i>[Blank]</i> DATE: <i>[Blank]</i> SHEET NUMBER SHOWN: <i>[Blank]</i> SHEETS OF SET: <i>[Blank]</i>



**USC DESIGN GUIDELINES**

**2. PROCEDURAL REQUIREMENTS – None**

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 33 1000 WATER UTILITY SYSTEMS

### 1. OVERVIEW

#### A. University Park Campus (UPC)

- I. Purpose: USC preferences and requirements are indicated in this document. For other related requirements, refer to Section 33 11 00 Water Utility Distribution Piping, 21 00 00 Facility Fire Suppression AND 33 00 00 Order of Inverts.
- II. USC has three points of connection to the LADWP public water mains (Refer to Fig -1). This water is supplied from LADWP's Silverlake and Hollywood Reservoirs.
  - a. Vermont Avenue approximately 100 feet south of Jefferson Boulevard (3400 S Vermont Ave)
  - b. Vermont Avenue approximately 300 feet south of 36th Place (3400 S Vermont Ave)
  - c. Figueroa Street approximately 160 feet north of Exposition Boulevard (3601 S Figueroa St)
  - d. Request for LADWP SAR's –The design team shall be required to request an SAR from LADWP for all (3) campus meters. (3) separate water calculations shall be performed in order to determine the best scenario for the project site. The formalized Water Calculation shall be based on the greatest available water pressure for the project site for domestic water and fire water.
- III. The campus domestic water system is private and a combined fire and domestic main inspected by the City of Los Angeles, Los Angeles County and USC FPM Facilities.

#### B. Other USC facilities Including Health Science Campus (Except Catalina Campus)

- I. Purpose: USC preferences and requirements are indicated in this document. For other related requirements, refer to Section 33 11 00 Water Utility Distribution Piping, 21 00 00 Facility Fire Suppression AND 33 00 00 Order of Inverts.
- II. Other USC facilities are served by Local Water Purveyors and are all public water system sources.
- III. All connections to public water mains and new water meters to be coordinated with the Local Water Purveyors.

#### C. Any work in Catalina Campus to be coordinated with USC

## USC DESIGN GUIDELINES

D. The following table summarizes the types of particular requirements identified within this section for all USC Campuses unless noted otherwise:

<b>Domestic Water/Combined Main</b>			
<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Testing/ Inspection</b>
<ul style="list-style-type: none"> <li>• PVC, Type K copper Pipes (NPS 1/8 to NPS 3 ½). PVC, AWWA Pipe (NPS 4 to NPS 12): AWWA C900, Class 305 (DR-14)</li> <li>• Ductile iron fittings with fully restrained joints.</li> <li>• Gate valve on building laterals</li> <li>• Valves: AWWA, UL/NSF/FM Cast-Iron, Gate Valves, Resilient Wedge. Valve boxes shall be precast concrete with cast iron traffic covers. Traffic box lid shall be circular with the word "WATER" embossed on the top surface.</li> <li>• Tee connection to combined mains.*</li> <li>• Coordinate water main shut down with the university project manager 2 weeks in advance.</li> <li>• Color coding of water main per AWWA standards.</li> <li>• All City of Los Angeles and LA County Department of Public Health system guidelines to be followed. Requirement due to reclaimed water mains on campus.</li> <li>• All appurtenances to have an approved City of Los Angeles</li> </ul>	<ul style="list-style-type: none"> <li>• Refer to sections below</li> </ul>	<ul style="list-style-type: none"> <li>• Hot taps to private water mains.*</li> <li>• Backflow Preventors on building domestic lateral connections to private main unless serving a Lab building*</li> <li>• Tee connection smaller than 4 inches to combined mains.*</li> </ul>	<ul style="list-style-type: none"> <li>• Chlorination, hydrostatic pressure testing and witnessed flushing of all new piping systems.</li> </ul>

## USC DESIGN GUIDELINES

<p>Research Report Number and/or require a one time approval and any additional related inspections from the City of Los Angeles.</p> <ul style="list-style-type: none"> <li>• All lateral tees to be no smaller than 4" off local main.</li> <li>• C900 lateral shall be extended outside of street or traffic rated hardscape limits, before transitioning in both size and material.</li> </ul>			
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<b>Fire Protection/Combined Main</b>			
<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Testing/ Inspection</b>
<ul style="list-style-type: none"> <li>• PVC, AWWA Pipe (NPS 4 to NPS 12): AWWA C900, Class 305 (DR 14), UL Listed/FM Approved with bell-and-spigot or double-bell ends.</li> <li>• Ductile iron fittings with fully restrained joints.</li> <li>• Backflow prevention required with OS&amp;Y (with chain and lock) or separate PIV on building laterals.</li> <li>• No underground or direct buried gate valves allowed on building laterals.*</li> <li>• Coordinate sizing &amp; equipment with fire sprinkler contractor and building systems.</li> <li>• Valves: AWWA, UL/NSF/FM Cast-Iron, Gate Valves.</li> <li>• Valve boxes shall be precast concrete with cast iron traffic covers. Traffic box lid shall be circular with the word "WATER" embossed on the top surface.</li> </ul>	<ul style="list-style-type: none"> <li>• Fire hydrants at all major intersections shall be installed inside of main cross fitting where possible.</li> </ul>	<ul style="list-style-type: none"> <li>• Hot taps to private water mains.*</li> </ul>	<ul style="list-style-type: none"> <li>• Flow testing of existing fire hydrants to be coordinated with the university with a minimum 2 week notice.</li> <li>• Chlorination , hydrostatic pressure testing and witnessed flushing of all new piping systems.</li> <li>• Refer to the USC Fire Watch Standards in the case a fire watch is required.</li> </ul>

## USC DESIGN GUIDELINES

<ul style="list-style-type: none"><li>• Tee connection to combined mains.*</li><li>• Coordinate water main shut down with the university project manager 2 weeks in advance.</li><li>• Color coding of water main per AWWA standards.</li><li>• All City of Los Angeles and LA County Department of Public Health system guidelines to be followed. Requirement due to reclaimed water mains on campus.</li><li>• All appurtenances to have an approved City of Los Angeles Research Report Number and/or require a one time approval and any additional related inspections from the City of Los Angeles.*</li></ul>			
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*\* Applies to UPC Campus*

*\*\* Applies to Non-UPC Campuses Only*

### 2. CODES AND STANDARDS

- A. NFPA 13, Installation of Sprinkler Systems
- B. Underwriters Laboratories (UL) Fire Protection Equipment Directory
- C. California Building Code - Latest Version
- D. City of Los Angeles Fire Code - Latest Version
- E. California Fire Code - Latest Version
- F. Title 19 of California Code of Regulations
- G. University of Southern California Design Standards

### 3. PROCEDURAL REQUIREMENTS

- A. Considerations specific to components in this section:
  - 1. Required for Domestic Water/Fire Protection/Combined Main Line:

## USC DESIGN GUIDELINES

- a. Coordinate water main shut down with the university project manager 2 weeks in advance.
- b. Color coding of water main per AWWA standards.
- c. All City of Los Angeles and LA County Department of Public Health system guidelines to be followed including warning tapes. Installation of tracer wire and pipe markers.
- d. All appurtenances to have an approved City of Los Angeles Research Report Number and/or require a onetime approval from the City of Los Angeles.
- e. All lateral tees to be no smaller than 4" off local main.
- f. All piping and fittings shall be hydrostatically pressure tested for 200 PSI working pressure.
- g. Hydrostatic pressure testing shall be limited to new pipe and fittings being installed. Means for isolating new piping systems shall be provided to avoid hydrostatic pressure testing through existing water system.
- h. Owner to retain third party Inspector of Record to provide continuous inspection of the installation of underground combined domestic/fire water main lines to include, but not limited to:
  - 1) Materials delivered to site
  - 2) Field joint closure work
  - 3) Lateral tee connections to main lines
  - 4) Thrust blocks
  - 5) Pressure testing
  - 6) Chlorination
  - 7) Flushing
  - 8) Backfill
- i. Existing laterals being taken out of service shall not be abandoned in place and shall be cut, capped and restrained at connection to main.
- j. Means for providing temporary service to buildings during utility upgrades shall be accounted for and coordinated with the university.
- k. System piping shall be hydrostatically tested at 200 psi for two hours or at 50 psi above the maximum system operating pressure, whichever is greater.

## USC DESIGN GUIDELINES

- l. Fire department connections shall be located on the address side of the building, face the street, be visible and accessible, approved check valve located in the main line (as close to inlets as possible).
  - m. All valves and fire department connections shall have permanently affixed signs, indicating their function.
  - n. The following notes shall be on the plans when a private hydrant is proposed:
    - 1) All private hydrants shall flow a minimum of 1250 gpm at 20 psi for duration of two hours. If more than one on-site fire hydrant is required, the on-site flows shall be at least 2500 gpm at 20 psi, flowing from the most hydraulically remote hydrants simultaneously. On-site flows shall match the public flow requirements.
    - 2) All private on-site fire hydrants shall be installed a minimum of 25 feet from a structure or protected by a two-hour firewall to the highest portion of the building, adjacent to the hydrant.
    - 3) Each private fire system shall have a main post indicator valve, or other approved valve, at the city connection on the system side of the detector check valve.
    - 4) All private on-site fire hydrants shall be equipped with a shut-off (gate) valve, which is located at least 10 feet, and not more than 25 feet from the fire hydrant. The location may be less than 10 feet when the water main is existing, and the 10-foot minimum distance cannot be satisfied. The shut-off valve shall be readily accessible at all times (locating it under a parking stall is not allowed).
    - 5) The fire protection contractors will provide the University with the necessary instruction manuals for the upkeep of the system.
- B. Permits required for Domestic Water/Fire Protection/Combined Main Line:
- 1. Los Angeles Department of Building & Safety (LADBS) Mechanical Plan Check for Plumbing Permit  
Conditions:
    - a. New domestic water lateral for proposed building.
    - b. New fire water lateral for proposed building.
  - 2. Los Angeles Department of Building & Safety (LADBS) Mechanical Plan Check for Fire Sprinkler Permit  
Conditions:
    - a. Replace existing combined water main.

## USC DESIGN GUIDELINES

- b. New or relocated fire hydrant.
  - c. Reconnection of existing fire hydrant to new or existing combined water main.
  - d. New fire water lateral for proposed building.
  - e. Reconnection of existing building lateral to new water main.
3. Los Angeles Fire Department (LAFD) Division 5 Permit for laterals and fire hydrants

Conditions:

- a. New or relocated fire hydrant.

#### 4. PRODUCT REQUIREMENTS

##### A. Fire department connection (FDC)

###### 1. Required:

- a. One FDC shall serve all automatic sprinkler systems on a subject property.
- b. The FDC shall be installed on the address side of the building within 150 feet (via vehicular access) of an accessible public fire hydrant. The FDC shall be located as close to the street curb face as possible
- c. The FDC shall be visible, accessible (three feet clear above and no more than 42 inches above the level of grade) with the FDC facing the street. When a fence or other obstruction is provided, the FDC shall be accessible from the public side of the obstruction.
- d. Signs shall indicate the type of system, address, buildings served by the FDC, and system pumping pressure if greater than 150 psi.
- e. FDC shall be located a minimum of 25 feet from the structure. When this distance cannot be achieved, a minimum two-hour fire resistive wall shall be provided with no openings in the wall, 25 feet in either direction of the FDC.
- f. Systems designed for a total water demand up to 1,000 gallons shall be provided with a single, listed, clappered body FDC, having two 2 ½" inlets siamesed into a minimum 4" pipe with a 4" check valve.
- g. Systems designed for a total combined water demand exceeding 1,000 gpm up to 2,000 gpm shall be equipped with a single, listed, clappered body FDC, having four 2 ½" inlets siamesed into a minimum 6" pipe with a 6" check valve.



## USC DESIGN GUIDELINES

- h. Systems designed for a total combined water demand exceeding 2,000 gpm shall be equipped with a single, clappered body FDC, or approved equal, having six-2 ½" inlets siamesed into a minimum 6" pipe with a 6" check valve.
  - i. The combined water demand for FDC sizing shall be determined by adding the highest single system demand to the inside hose or standpipe system, if provided, and if there is a private hydrant, outside hose requirement.
  - j. When an FDC is designed to pressurize more than one private hydrant as well as the sprinkler systems, a minimum of 1,000 gpm shall be used as the outside hose requirements for determining the combined water demand for FDC sizing. Assume 500 gpm maximum for each FDC inlet.
  - k. The FDC pipe sizing shall be sized to provide the highest single sprinkler system demand plus any inside and outside hose demands, or standpipe system demand, based on a maximum pressure of 150 psi at the FDC inlets.
2. Preferred Manufacturers:
- a. Badger-Powhatan
  - b. Elkhart Brass
  - c. Croker Corp.
  - d. Potter-Roemer
  - e. Tyco Fire Products, or equal.
3. Disallowed: None
- B. System control valves
1. Required:
- a. System control valves shall be of an indicating type valve assembly.
  - b. Each sprinkler riser shall have a readily visible, accessible above grade exterior indicating control valve.
  - c. Each fire protection system shall have a main post indicator valve (PIV) located at the city connection, on the supply side of the FDC.
  - d. Systems with a backflow prevention device may use the system side OS&Y valve to meet the requirements of the PIV (above), provided the valve is clearly visible and accessible at all times from the fire department access road.

## USC DESIGN GUIDELINES

- e. Wall post indicator valves may be used as the systems main control valve were short lengths of underground exist. (A listed indicating control valve may be used only when the riser is on the exterior of the building and readily visible and accessible). Note: The FDC shall be tied in on the system side of this control valve when feeding a single sprinkler system.
- f. In multi-story/level buildings (including basements) over three levels, the following devices shall be provided at each floor level in a rated shaft or stairway:
  - Indicating control valve
  - Water flow detector with an alarm bell
  - Drain valve
  - Inspectors test valve with sight gauge
- g. Sectional control valves for underground fire mains shall be post indicator type (PIV). In unique situations when above ground valves cannot be used, a central station service monitored electronically supervised indicating valve in an approved vault may be allowed. Valves shall be provided as follows:
  - Provide a sectional control valve on each side of the supply connection to the loop and one at the opposite side of the loop. This also applies to systems which “Y” or split into two or more separate legs, but do not actually complete a loop.
  - Sectional control valves shall be required for each combination of five sprinkler risers and/or hydrants. Rack sprinkler risers need not be counted when determining these units.
- h. Underground piping serving both on-site hydrants and sprinkler systems shall be designed whereby on-site hydrants will not be shut off when the sprinkler systems exterior control valve is turned off.
- i. System control valves and FDCs shall have a permanent sign identifying areas or systems controlled. Signs shall be metal, have raised lettering, painted white with minimum red letters 1” high with 3/16” stroke and shall be permanently banded to the valve or permanently affixed to a wall.
- j. All control valves shall be locked in the open position, with a non-case-hardened lock.
- k. All control valves shall be readily accessible and located within 7’-0” above the floor.
- l. Sprinkler systems located in special hazard areas (i.e., spray booth, trash chutes, etc.) shall have a separate indicating control valve. This valve shall be supervised in the same manner as the building’s sprinkler system control valve.

- 2. Preferred: No preferences.

## USC DESIGN GUIDELINES

3. Disallowed:
  - a. Underground gate valves are not acceptable for sprinkler system control valves.
- C. Gate Valve:
  1. Preferred manufacturers:
    - a. Grinnell Corporation
    - b. Mueller Co, Water Products Div.
    - c. McWane Inc
    - d. Clow Valve Co
    - e. Tyler Pipe, Utilities Division
    - f. United States Pipe and Foundry Company
- D. Reduced Pressure Principle (RPP) or Zone Backflow Prevention Assembly (RPZ):
  1. Acceptable manufacturers:
    - a. For 2.5" to 6": Wilkins
      - 1) Preferred Model: 375 RPP
    - b. For greater than 6": Watts
      - 1) Preferred Model: LF909-FS Large
- E. Fire Hydrant
  1. Acceptable manufacturers:
    - a. Clow Valve Company
      - 1) Preferred Model: Clow Valve 860, OSHA yellow
- F. Special Requirements
  1. Required
    - a. All underground mains serving private on-site hydrants shall be calculated to verify the required on-site fire flow.
    - b. When pressure-reducing valves (PRV) are used, an approved device for full flow testing shall be provided after the valve and discharged to an approved location. (A minimum 2" main drain valve shall be provided when using 2 ½" PRVs).
    - c. Class 1 standpipes for non-high rise buildings shall be designed as manual wet, and calculated such that a maximum 150 psi is required at the FDC to provide the minimum residual pressure required at the most remote valve outlets.

## USC DESIGN GUIDELINES

### 5. INSTALLATION REQUIREMENTS

#### A. Required:

1. Water Main Connection: Coordinate connection and associated service interruptions with University Representative. Install mechanical joint fittings at point of connection to main and gate valve on installed lateral per University requirements. Hot taps to the private water mains are prohibited.

Tracer Wire: Install continuous length of tracer wire for full length of each run of non-metallic pipe. Fasten wire to top of pipe in such a manner that it will not be displaced during construction operations. Wire shall be fastened to pipe at intervals not exceeding 20 feet. Wire shall terminate at surface in an in ground traffic rated access box labeled "water" directly adjacent to all gate valves and fire hydrants.

2. Underground Pipe Markers: Provide markers at grade where non-metallic pipe is installed and for each horizontal change in direction. All City of Los Angeles and LA County Department of Public Health system guidelines to be followed, including warning tapes, installation of tracer wire and pipe markers
3. Provide means of temporary restraining pipe where service cannot be completely isolated and/or within 10 feet of known existing water fitting/valve.
4. Utility Trench Backfill
  - a. Refer to section 33 00 00 for trench backfill requirements, order of inverts and clearances for IT, security, electrical, telecom, reclaimed water, sanitary sewer, storm drain and mechanical buried pipes.
  - b. Install warning tape directly above utilities, minimum 6 inches above top of pipe, minimum 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.
  - c. Repair disturbed pavement per University requirements. Replace affected pavement to match existing at minimum unless otherwise noted.
5. Domestic Water/Combined Main
  - a. PVC, Schedule 40 Pipes (NPS 1/8 to NPS 3 1/2). PVC, AWWA Pipe (NPS 4 to NPS 12): AWWA C900, Class 305 (DR 14)
  - b. Ductile iron fittings with fully restrained joints.
  - c. Gate valve on building laterals

## USC DESIGN GUIDELINES

- d. Refer to Blanket Protection for Pipes detail when the clearance between the top of the existing pipe and the bottom of the crossing pipe is less than 18 inches.
  - e. Tee connection to combined mains.
  - f. Backflow prevention on domestic water laterals to LAB buildings.
6. Fire Protection/Combined Main
- a. PVC, AWWA pipe (NPS 4 to NPS 12): AWWA C900, Class 305 (DR 14), UL Listed/FM Approved with bell-and-spigot or double-bell ends.
  - b. Ductile iron fittings with fully restrained joints.
  - c. Backflow prevention required with OS&Y (with chains and locks) or separate PIV on building laterals.
  - d. No gate valves on building laterals
  - e. Refer to Blanket Protection for Pipes detail when the clearance between the top of the existing pipe and the bottom of the crossing pipe is less than 18 inches.
  - f. Tee connection to combined mains
  - g. All private on-site fire hydrants shall be installed to the following specifications, prior to flow test and acceptance of the system:
    - 1) Installed so that the centerline of the lowest outlet is between 14 and 24 inches above finished grade.
    - 2) Installed so that the front of the riser is between 12 and 24 inches behind the curb face
    - 3) Installed so that the outlets are facing the curb at a 45-degree angle to the curb line
    - 4) Of a type and construction which conforms to current American Water Works Association Standard C503
    - 5) Provided with a 3-foot unobstructed clearance on all sides.
    - 6) Installed so that the fire hydrant is centered on a 3' x 3' x 1' thick concrete pad.
    - 7) Provided with approved plastic outlet caps
    - 8) All private on-site water mains, laterals, gate valves, buries, and risers feeding private fire hydrants shall be a minimum of six inches in diameter.
    - 9) When sidewalks are contiguous with a curb and have a width of five feet or less, the front of the fire hydrant riser shall be placed immediately behind the sidewalk. In no case shall a fire hydrant be more than six feet from a curb face.
    - 10) Approved fire hydrant barricades shall be installed if curbs are not provided (see V7-C1-S8).
    - 11) Piping shall be hydrostatically tested at 200 psi for two hours or at 50 psi above the system operating pressure, whichever is greater

## USC DESIGN GUIDELINES

12) Adequate (10 feet per second) flushing of the piping, in accordance with NFPA 13.

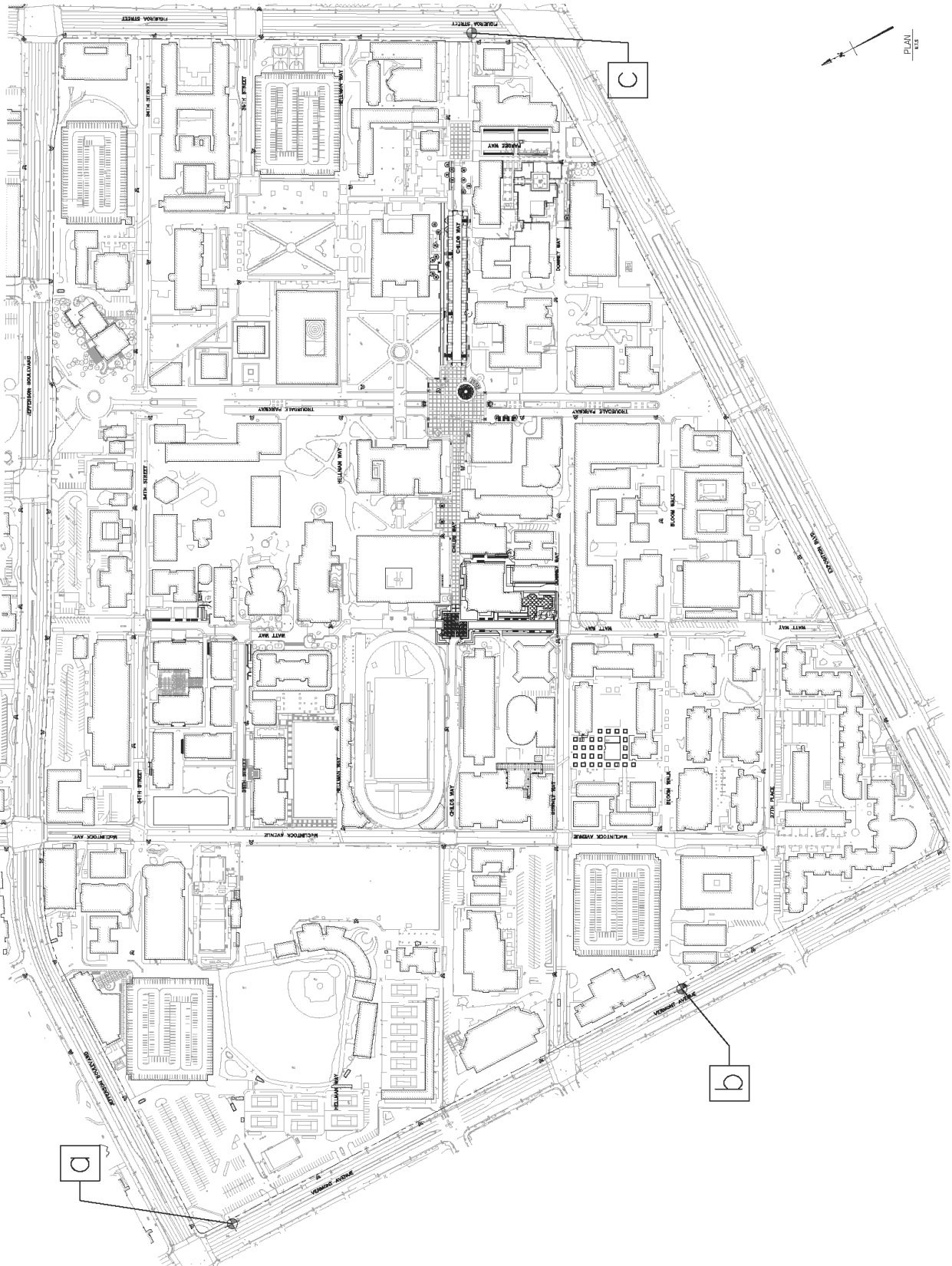
13) Flow test to satisfy fire flow requirements

### B. Disallowed:

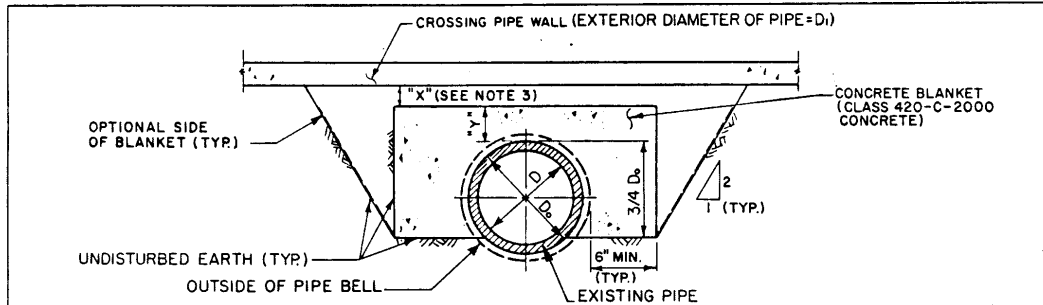
1. Hot taps to private water mains.
2. Backflow Preventers on building domestic water laterals where off private water main unless serving a Lab building or instructed otherwise by USC.
3. Demolition and removal of existing domestic/fire water laterals by cutting and capping.
4. Installation shall not begin until plans have been approved by Engineering Services and the fire department. A complete set of approved plans shall be kept at the building site at all times. Contractors installing system without approved plans may be cited.

# USC DESIGN GUIDELINES

## FIG 1 - USC UPC WATER MAIN POINTS OF CONNECTION



# USC DESIGN GUIDELINES

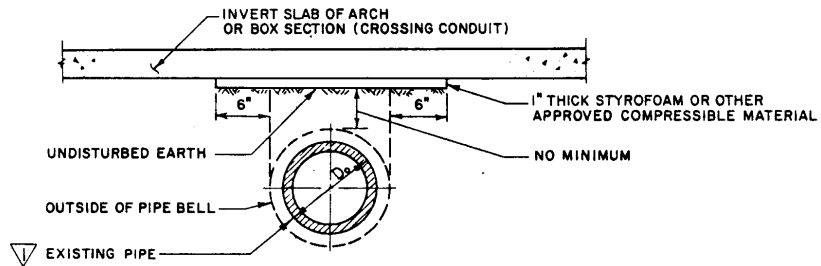


## CONCRETE BLANKET

(FOR EXISTING PIPES CROSSED OVER BY A NEW PIPE)

**NOTES FOR CONCRETE BLANKET:**

1. CONCRETE BLANKET IS REQUIRED WHEN THE CLEARANCE BETWEEN THE TOP OF THE EXISTING PIPE AND THE BOTTOM OF THE CROSSING PIPE IS LESS THAN 18 INCHES.
2. "y" =  $D_p/6$ , 4 INCHES MINIMUM (WHERE THE CLEARANCE BETWEEN THE TOP OF THE EXISTING PIPE AND THE BOTTOM OF THE CROSSING PIPE IS LESS THAN "y", THE CONCRETE SHALL BE PLACED BETWEEN THE PIPES AND AROUND THE SIDES OF THE CROSSING PIPE UP TO A LEVEL EQUAL TO "y" ABOVE THE EXISTING PIPE, OR AS REQUIRED BY NOTE 3 BELOW, WHICH EVER IS HIGHER.)
3. "x" =  $D_c/8$  MINIMUM, TO PROVIDE BEDDING MATERIAL FOR THE CROSSING CONDUIT, WHEN "x" IS LESS THAN THIS MINIMUM, THE ENTIRE TOP SURFACE OF THE BLANKET SHALL EXTEND TO A LEVEL OF  $0.15D_c$  ABOVE THE BOTTOM OF THE CROSSING PIPE.
4. THE BLANKET SHALL EXTEND LONGITUDINALLY BEYOND THE TRENCH EXCAVATION TO ONE FOOT BEFORE THE FIRST PIPE JOINTS, EXCEPT THAT THE BLANKET NEED NOT EXTEND MORE THAN 4 FEET BEYOND EACH SIDE OF THE TRENCH.



## COMPRESSIBLE BLANKET

(FOR EXISTING PIPES CROSSED OVER BY A NEW BOX OR ARCH)

**NOTES FOR COMPRESSIBLE BLANKET:**

1. COMPRESSIBLE BLANKET IS REQUIRED WHEN THE CLEARANCE BETWEEN THE TOP OF THE EXISTING PIPE AND THE BOTTOM OF THE CROSSING CONDUIT (BOX OR ARCH) IS LESS THAN 18 INCHES.
2. THE BLANKET SHALL EXTEND LONGITUDINALLY FOR THE FULL CROSSING CONDUIT TRENCH WIDTH.

BUREAU OF ENGINEERING		DEPARTMENT OF PUBLIC WORKS		CITY LOS ANGELES	
<b>BLANKET PROTECTION FOR PIPES</b>			<b>STANDARD PLAN S-255-1</b>		
SUBMITTED <i>11/6</i> 1987 <i>[Signature]</i> ENGINEER OF RECORD DEPUTY ENGINEER		NO.	REVISIONS	SUPERSEDES	REFERENCES
APPROVED <i>12/16</i> 1987 <i>[Signature]</i> CITY ENGINEER		1	REVISOR'S DESCRIPTION REVISED NOTES 2, 3 AND 4. CHANGED "EXISTING CONDUIT" TO "EXISTING PIPE".	B-3980	
DESIGNED BY: LIE DRAWN BY: RGM CHECKED BY: LJM				VAULT INDEX NUMBER B-4095	
				SHEET 1 OF 1 SHEETS	



## USC DESIGN GUIDELINES

### 5. TESTING AND INSPECTION

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Required Items:
1. Flow testing of existing fire hydrants to be coordinated with the university with a minimum 2 week notice.
  2. Chlorination, hydrostatic pressure testing and witnessed flushing of all new piping systems.
  3. Pipe installation to be coordinated with City of Los Angeles Building & Safety, City of Los Angeles DWP and Los Angeles County Health Department.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 33 1700 RECLAIMED WATER SYSTEM

### 1. OVERVIEW

#### A. University Park Campus (UPC)

- I. Purpose: USC preferences and requirements are indicated in this document. For other related requirements, refer to Section 33 11 00 Water Utility Distribution Piping AND 33 00 00 Order of Inverts.
- II. The campus reclaimed water system is private and inspected by the City of Los Angeles, Los Angeles County Health Department and USC FPM Facilities.
- III. The campus reclaimed water system currently has no source and is being planned, designed, permitted and constructed where feasible in anticipation of a future source.

## USC DESIGN GUIDELINES

- B. The following table summarizes the types of particular requirements identified within this section for USC UPC Campus unless noted otherwise:

<b>Reclaimed Water</b>			
<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>	<b>Item Requiring Testing/inspection</b>
<ul style="list-style-type: none"> <li>• PVC, AWWA Pipe (NPS 4 to NPS 12): AWWA C900, Class 305 (DR 14), Purple Pipe with bell-and-spigot or double-bell ends.</li> <li>• Ductile iron fittings with fully restrained joints.</li> <li>• Valve boxes shall be precast concrete with cast iron traffic covers. Traffic box lid shall be triangular with the word "RECLAIMED WATER" embossed on the top surface.</li> <li>• Valves: AWWA, UL/NSF/FM Cast-Iron, Gate Valves</li> <li>• Coordinate water main shut down with the university project manager 2 weeks in advance.</li> <li>• All City of Los Angeles and LA County Department of Public Health system guidelines to be followed including warning tapes, color coding, installation of tracer wire and pipe markers.</li> <li>• All appurtenances to have an approved City of Los Angeles Research Report Number and/or require a onetime approval and any additional related inspections from the City of Los Angeles.</li> <li>• Laterals for future use inside building subject to different requirements and oversight. Coordinate with the university project manager.</li> </ul>			<ul style="list-style-type: none"> <li>• Hydrostatic pressure testing.</li> <li>• Pipe installation inspection to be coordinated with City of Los Angeles DWP and Los Angeles County Health Department.</li> </ul>

# USC DESIGN GUIDELINES

## 2. PROCEDURAL REQUIREMENTS

### A. Required for Reclaimed Water Line:

- a) 10-foot minimum horizontal separation from any new potable or combined domestic and fire water line.
- b) 1-foot minimum vertical separation from any new potable or combined domestic and fire water line, with potable water at the higher elevation.
- c) When any new potable or combined domestic and fire water line cross with a reclaimed water line and sewer line, install the sewer line below the reclaimed water line, below the potable water line.
- d) When any new potable or combined domestic and fire water line cross with a reclaimed water line, the reclaimed water line shall be installed within a protective sleeve. The sleeve shall extend 10 feet from each side, from the centerline of the potable line, for a total of 20 feet.
- e) No retrofit of existing systems is required to accomplish separation where impractical. Other provisions shall be made to minimize the possibility of cross-connection to the satisfaction of the University or applicable jurisdiction.
- f) Contractor to coordinate chlorination and pressure testing procedures with USC FPM Facilities, City and County Inspectors 2 weeks prior to testing.
- g) Coordinate water main shut down with the university project manager 2 weeks in advance
- h) Color coding of water main per AWWA standards
- i) All City of Los Angeles and LA County Department of Public Health system guidelines to be followed, including warning tapes, installation of tracer wire and pipe markers
- j) All appurtenances to have an approved City of Los Angeles Research Report Number and/or require a onetime approval from the city of Los Angeles.
- k) Existing laterals being taken out of service shall not be abandoned in place and shall be cut, capped and restrained at connection to main.
- l) Any planning, design, permitting and construction of campus reclaimed water mains or laterals to be coordinated with Campus Reclaimed Water Master Plan and Master Plan Letter dated May 10, 2010 (Attached) on file with USC FPM Facilities and Los Angeles Department of Water and Power (LADWP).

### B. Permits required for Reclaimed Water Main:

1. Los Angeles Department of Building & Safety (LADBS) Mechanical Plan Check for Plumbing Permit

Conditions:

- a) New reclaimed water main or lateral for proposed building.

# USC DESIGN GUIDELINES



JONATHAN E. FIELDING, M.D., M.P.H.  
County Administrator

JONATHAN E. FREEMAN  
Chief Deputy Director

ANGELO J. BELLIOMO, R.E.M.S.  
Director of Environmental Health

AL FONSECA MEDINA, R.E.H.S.  
Director of Environmental Protection Bureau

Cross Connection & Water Pollution Control Program  
2750 Commerce Drive  
Downey, CA 90241  
Tel: (562) 490-5229 • Fax: (562) 610-3025

[www.cdph.ca/Programs/OPA/Pages/P090009.aspx](http://www.cdph.ca/Programs/OPA/Pages/P090009.aspx)

May 10, 2010

University of Southern California  
3434 S Grand Ave  
Los Angeles, CA 90089

Plan Check # 2010049  
Site ID # 101991  
Water Purveyor: LA DWP

Attention: Victor Aspinet, [v425@cdph.org](mailto:v425@cdph.org)

Subject: USC Recycled Water Main Plan Phase 1A to 5C – Recycled Water Use Site, RW Main,  
New  
3607 Trousdale Parkway Los Angeles, CA 90089  
Plans prepared by: Karen Egan, K297 Consulting Engineers 310.565.2800  
6680 Center Dr. # 360 Los Angeles, CA 90045

In response to the request for project review, this Department submits the following. The conceptual plans approved with the following conditions:

1. All recycled water (RW) projects, such as this one, shall be inspected and verified against the approved plans.
2. A Reduced Pressure Principle Backflow Prevention device is required on each potable water service, installed as close to the meter as practical, at least one foot above grade, accessible for testing and maintenance.
3. All exposed potable water mains and laterals shall be identified with continuous tags attached directly to the pipe and secured every five feet with the wording "potable water line." All new and exposed fire supply mains shall be identified as "Combustible Fire Line."
4. Submit an engineering report to California Department of Public Health, Drinking Water Program (213.580.5727) for the proposed project.
5. All newly installed recycled water mains and laterals shall be identified as outlined in the Guidelines for Recycled Water Use (see attached). The requirements for distances and sleeving of the water lines at domestic-potable water cross-overs, as well as the tagging and signage are outlined in the same attachment. All spaces between potable and recycled water meters shall be separated no less than ten (10) feet apart.
6. The use of recycled water is not allowed until a final approval is issued by this Department.



BOARD OF SUPERVISORS

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David Greer  
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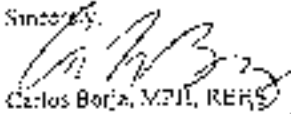
## USC DESIGN GUIDELINES

USC Recycled Water Main Plan Phase 1A to 5C  
Site Address: 3607 Trousdale Parkway Los Angeles, CA 90009  
Page 7

Plan Check # 2010049

7. Call this office when scheduling pre-construction meetings as well as when construction begins and pipe lines are being installed. Inspection of the water lines prior to backfilling is required. During construction all pipelines shall be inspected by Department of Public Health in conjunction with the City's Building & Safety Department/Water Department for pipe line identification and separation prior to backfilling.
8. Backflow prevention devices installed at the service connections and internally shall be tested upon installation and the results forwarded to either the Water Department or Health Department depending where the backflow prevention device is installed, i.e. meter or internal protection (non-testable backflow prevention devices excepted).

Sincerely,



Carlos Borja, MPH, RPHS  
Chief Environmental Health Specialist  
Cross Connection & Water Pollution Control Program  
Department of Public Health, Bureau of Environmental Protection  
4650 Commerce Drive, Rm 216  
Baldwin Park, CA 91706  
(626) 430-5293 office  
(523) 842-9528 cell

Cc: C. Diep, State DPH  
E Jackson, Regional Water Quality Control Board  
Los Angeles DWP  
Los Angeles Building & Safety  
USC Building Engineer (941 W 55<sup>th</sup> Street, POA106C L.A., Ca. 90089)  
K Egan, Architect  
Q. Ly, LA County DPH  
File

# USC DESIGN GUIDELINES

## INSTALLATION REQUIREMENTS

### A. Required:

1. Tracer Wire: Install continuous length of tracer wire for full length of each run of non-metallic pipe. Fasten wire to top of pipe in such a manner that it will not be displaced during construction operations. Wire shall be fasted to pipe at intervals not exceeding 20 feet. Wire shall terminate at surface in an in ground traffic rated access box labeled "water" directly adjacent to all gate valves and fire hydrants.
2. Underground Pipe Markers: Provide markers at grade where non-metallic pipe is installed and for each horizontal change in direction
3. Los Angeles County Department of Health Warning Tape for Potable Water and Reclaimed Water: Install LACDPH approved warning tape on both reclaimed water and potable water lines in conjunction with typical warning tape installed directly over piping. Install continuous underground detectable warning tape during backfilling of trench for underground water-service piping. The warning tapes shall be installed directly on top of the pipe longitudinally, shall be centered, and shall be continuous in their coverage on the piping and fastened to each pipe length by plastic tape no more than 10 feet apart. Taping attached to sections of pipe before they are placed in the trench shall have flaps sufficient for continuous coverage.
  - a. Refer to section 33 00 00 for trench backfill requirements, order of inverts, vertical and horizontal clearances for IT, security, electrical, telecom, mechanical buried pipes, sanitary sewer, storm drain and water main.
  - b. Repair disturbed pavement per University requirements. Replace affected pavement to match existing at minimum unless otherwise noted.

## 4. PRODUCT REQUIREMENTS

### A. Required Items:

1. PVC, AWWA Pipe (NPS 4 to NPS 12): AWWA C900, Class 305 (DR 14), Purple Pipe with bell-and-spigot or double-bell ends.
2. Ductile Iron fittings with fully restrained joints.
3. Valve boxes shall be precast concrete with cast iron traffic covers. Traffic box lid shall be triangular with the word "RECLAIMED WATER" embossed on the top surface.

### B. Recommended Manufacturers:

1. Vinyltech

## **USC DESIGN GUIDELINES**

2. Diamond Plastics

### **5. TESTING AND INSPECTION**

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
Required Items:
  1. Hydrostatic pressure testing.
  2. Pipe installation to be coordinated with City of Los Angeles Building & Safety, City of Los Angeles DWP and Los Angeles County Health Department.

**END OF DOCUMENT**



# USC DESIGN GUIDELINES

## 33 3000 SANITARY SEWER SYSTEMS

### 1. OVERVIEW

#### A. University Park Campus (UPC)

- I. Purpose: USC preferences and requirements are indicated in this document. For other related requirements, refer to Section 33 31 00 Sanitary Utility Sewerage Piping AND 33 00 00 Order of Inverts.
- II. UPC campus is a combination of City of Los Angeles Sanitary Sewer System with easements and private mains/laterals.
- III. All connections to public sanitary sewer mains and or manholes to be coordinated with the appropriate governing agency.

#### B. Other USC Facilities Including The Health Science Campus (except Catalina Campus)

- I. Purpose: USC preferences and requirements are indicated in this document. For other related requirements, refer to Section 33 31 00 Sanitary Utility Sewerage Piping AND 33 00 00 Order of Inverts.
- II. Other USC Facilities are served by City of Los Angeles.
- III. All connections to public sanitary sewer mains and or manholes to be coordinated with the appropriate governing agency.

#### C. Any work in Catalina Campus to be coordinated with USC.

## USC DESIGN GUIDELINES

- D. The following table summarizes the types of particular requirements identified within this section for all USC Campuses unless noted otherwise:

<b>Sanitary Sewer</b> (Connection to City of Los Angeles/Other Governing Agency Systems)		
<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>
Sewer Availability to be obtained from the Governing Agency. <ul style="list-style-type: none"> <li>• City of Los Angeles - Sewer Capacity Availability Report (SCAR)</li> </ul>	PVC SDR 35 Laterals	Cast Iron Pipes for building laterals
Sewer Connection Permit to be obtained from the Governing Agency. <ul style="list-style-type: none"> <li>• City of Los Angeles - Sewer Connection Permit (S-Permit)</li> <li>• City of Los Angeles B-Permit Required for connections, modifications, addition to public maintenance holes or extension of public mains.</li> </ul>		
Sewer Fees per the Governing Agency. <ul style="list-style-type: none"> <li>• City of Los Angeles - Sewer Facilities Charge (SFC)</li> </ul>		
2.0% Minimum Slope for laterals Unless Otherwise Approved		
Manhole required for sewer lateral connection equal in size to main line or 8 inches and greater.	30" dia. Manhole lids	
Tracer wire required on all private non-metallic sanitary sewer piping.		
Double Clean out to be installed at building point of connection 5 feet outside building face.		
All connections to be per city/governing agency's standards at a minimum unless approved.		
Sewer main lines and maintenance holes are owned by City of Los Angeles.		

## USC DESIGN GUIDELINES

Engineer to confirm with the appropriate governing agency regarding pipe material for connection to city mains.		
Engineer to research available records associated with public sanitary sewer systems with appropriate governing agency.		
Where open air trash enclosure with washdown is proposed, provide dual drain to storm drain and sanitary sewer. Refer to Section 33 4000 for further details. Where covered trash enclosure with washdown is proposed, provide drain to sanitary sewer.	Fox Diversion Drain	

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
1. Required:
    - a) 2.0% Minimum Pipe Slope for laterals Unless Otherwise Approved
    - b) 3 ft/sec Minimum Flow Velocity
    - c) Sewer mains designed per City of Los Angeles Sewer Design Manual and Uniform Plumbing Code.
    - d) All science buildings that discharge acid waste shall have an acid resistant sewer and be neutralized prior to connection to the sanitary system.
      - Coordinate these systems with Division 22 and appropriate governing agency.
    - e) All dining facilities that discharge grease waste shall have interceptors to remove grease solids prior to connection to the sanitary system.
      - Coordinate these systems with Division 22 and appropriate governing agency.
    - f) Sewer Availability to be obtained from the Governing Agency.
      - City of Los Angeles-Sewer Capacity Availability Report (SCAR).
    - g) Sewer Connection Permit to be obtained from the Governing Agency
      - City of Los Angeles – Sewer Connection Permit (S-Permit).
      - City of Los Angeles B-Permit Required for connections, modifications, addition to public maintenance holes or extension of public mains.
    - h) Sewer Fees per the Governing Agency.
      - City of Los Angeles – Sewer Facilities Charge (SFC).
    - i) All connections to be per city/governing agency’s standards at a minimum unless approved.
    - ii) Double Clean out to be installed at building point of connection 5 feet outside building face.
    - j) Sewer main lines and maintenance holes are owned by City of Los Angeles.
    - k) Engineer to confirm with the appropriate governing agency regarding pipe material for connection to city mains.
    - l) Engineer to research available records associated with public sanitary sewer systems with appropriate governing agency.
  2. Preferred:

## USC DESIGN GUIDELINES

- a) Use PVC SDR 35 Pipe Unless Otherwise Approved.
- b) Cast Iron allowed for building laterals under certain circumstances, yet must be reviewed with FPM Facilities.

### 3. INSTALLATION REQUIREMENTS

#### A. Required:

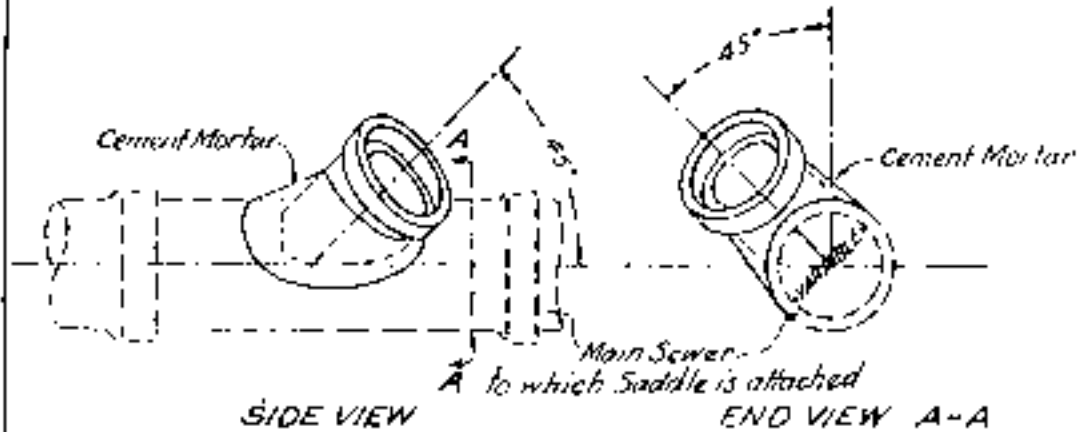
1. Refer to City of Los Angeles Standard Plans, Standard Specifications for Public Works Construction "Greenbook" and typical installation details (see below) where appropriate. Confirm installation details are most current.
2. Manhole required for sewer lateral connection equal in size to main line or 8 inches and greater. For all private manholes, please provide 30" diameter manhole lids.
3. Tracer Wire: Install continuous length of tracer wire for full length of each run of non-metallic pipe. Fasten wire to top of pipe in such a manner that it will not be displaced during construction operations. Wire shall be fastened to pipe at intervals not exceeding 20 feet. Wire shall terminate at surface in an in ground traffic rated access box labeled "sewer" directly adjacent to a private manhole, cleanout or junction structure.
4. Repair disturbed pavement per University requirements. Replace affected pavement to match existing at minimum unless otherwise noted.

#### B. Preferred: None

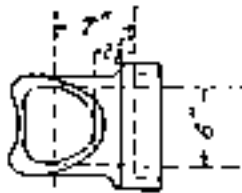
USC DESIGN GUIDELINES

CITY OF LOS ANGELES  
**STANDARD SADDLE CONNECTION**

A. G. HANSEN, CITY ENGINEER  
Approved 3 10 1910  
*S. C. Mumford*  
City Engineer.



**ELEVATIONS**  
Showing method of placing Saddle.



**PLAN OF SADDLE**  
Showing Contact Opening

**— NOTE —**

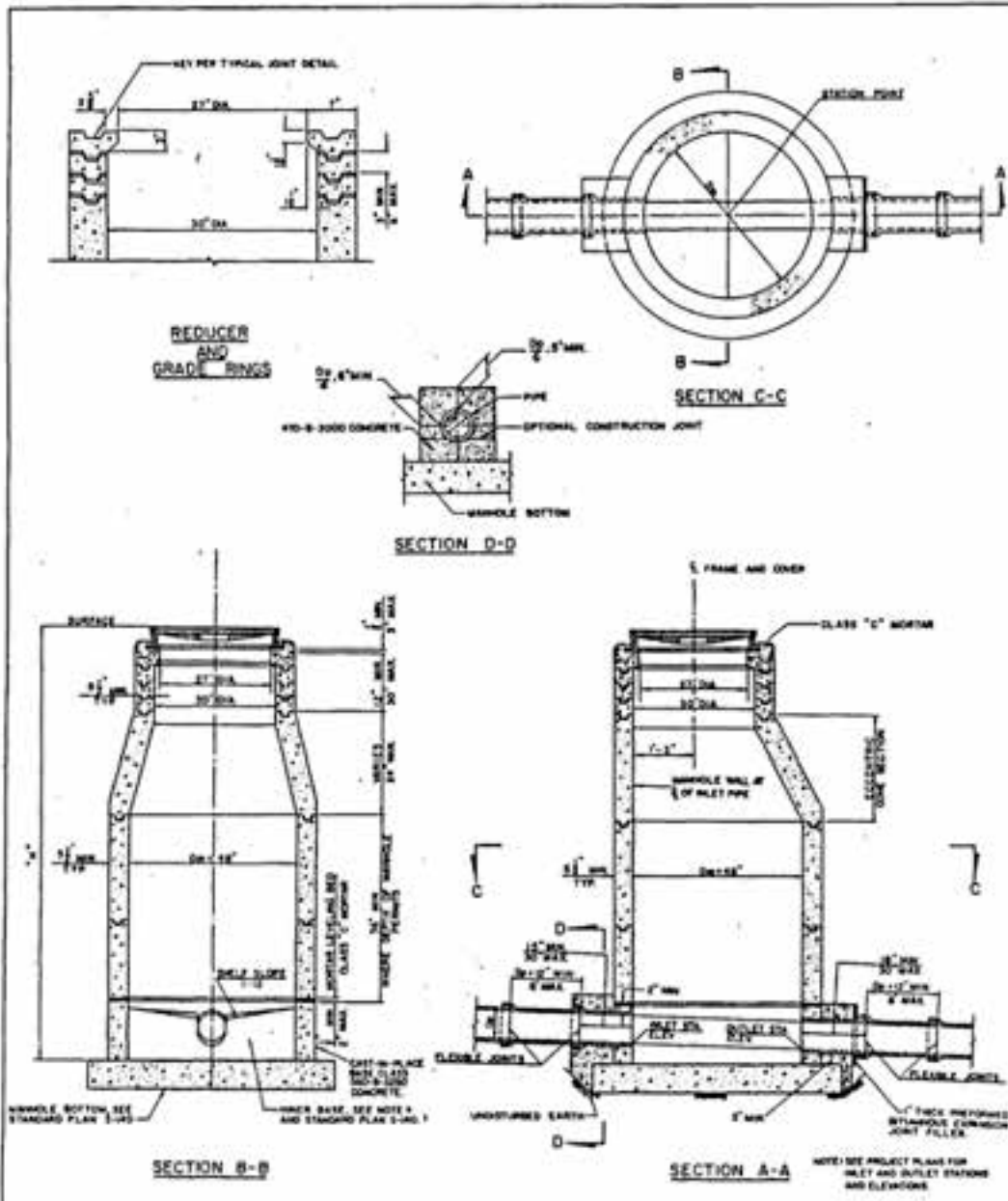
Opening in Main Sewer shall be cut to exactly fit the saddle which latter shall be properly bedded and enveloped with cement mortar as shown.

Drawn by A. G. H.  
Checked, L. C. Mumford  
Approved, 10/10/10



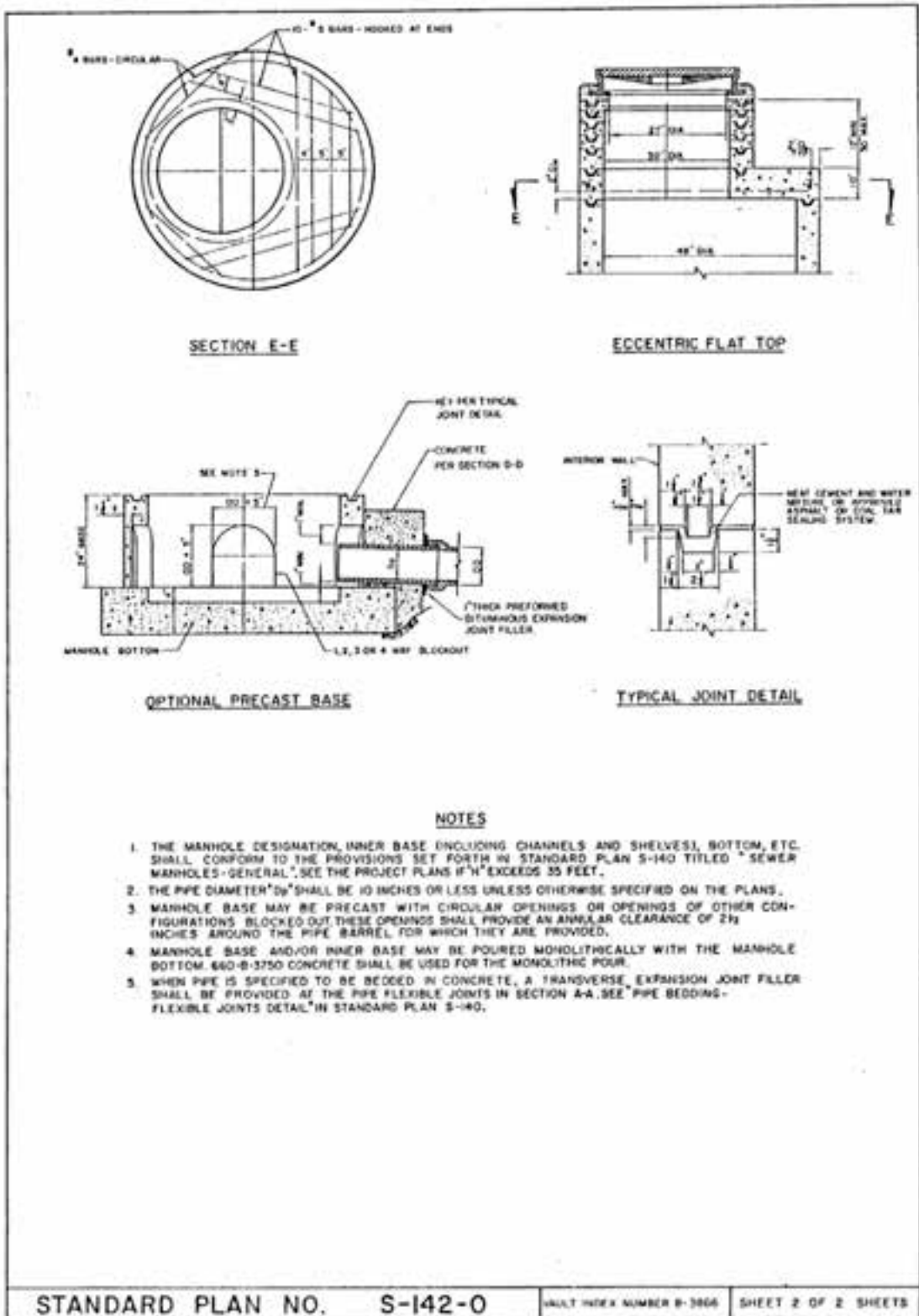
# USC DESIGN GUIDELINES

For Public City of LA Sanitary Sewer Manholes:



BUREAU OF ENGINEERING		DEPARTMENT OF PUBLIC WORKS		CITY OF LOS ANGELES	
PRECAST CONCRETE SEWER MANHOLE				STANDARD PLAN S-142-0	
SUBMITTED: 2/26/1976 APPROVED: 3/10/1976 DRAWN BY: J. HANSEN CHECKED BY:		REVISIONS NO. DATE DESCRIPTION DIV. ENGR. CITY ENGR.		SUPERSEDES: DL-2468 REFERENCES: S-140 S-280	
MANHOLE BOTTOM SEE STANDARD PLAN S-142 INNER BASE SEE NOTE 1 AND STANDARD PLAN S-142				NOTE: SEE PROJECT PLANS FOR INLET AND OUTLET STATIONS AND ELEVATIONS	
SHEET 1 OF 2 SHEETS					

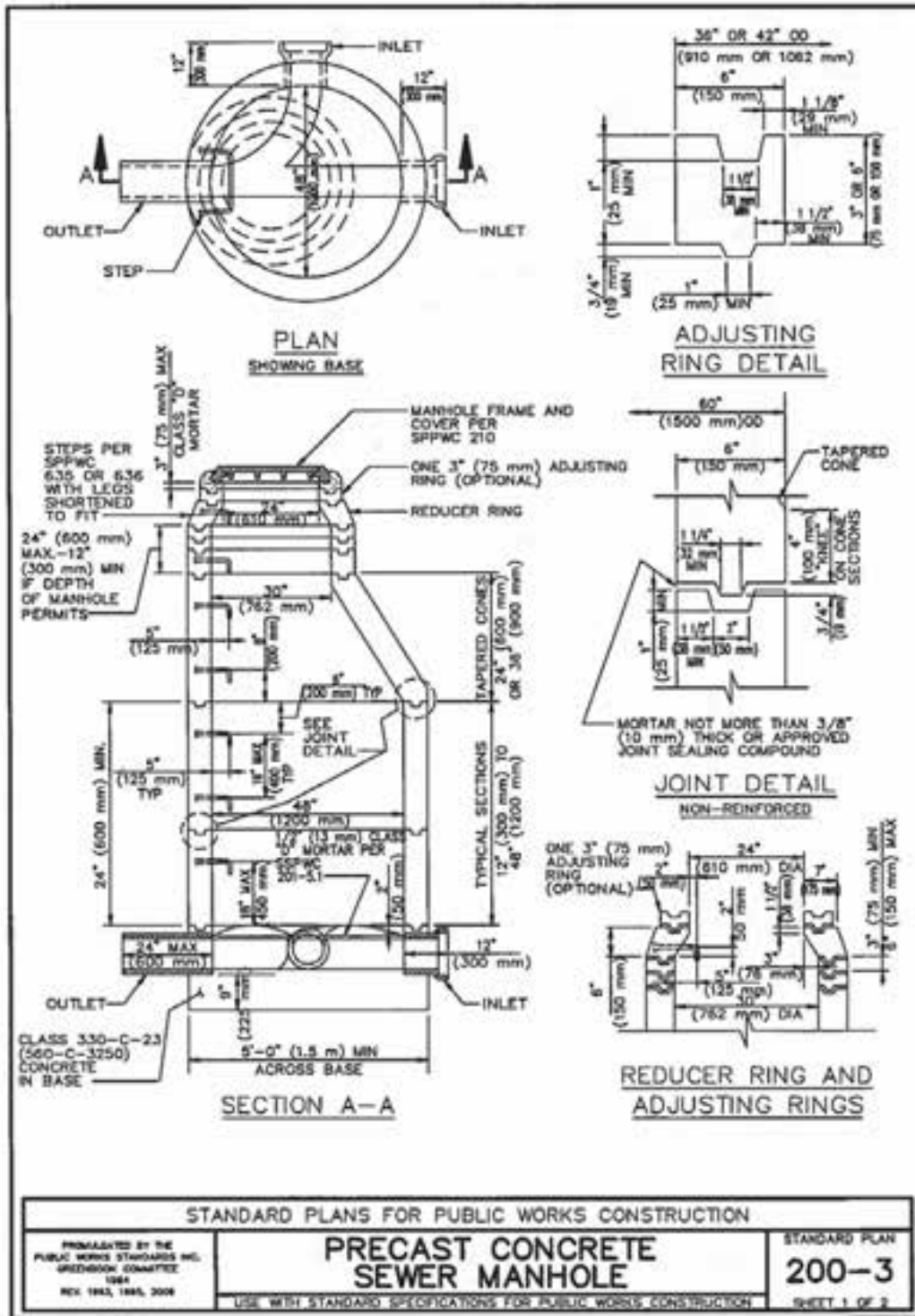
# USC DESIGN GUIDELINES





# USC DESIGN GUIDELINES

For Private Sanitary Sewer Manholes:



## USC DESIGN GUIDELINES

### NOTES:

1. EXCEPT AS NOTED HEREON, THE PRECAST UNITS SHALL BE MANUFACTURED AND TESTED IN ACCORDANCE WITH ASTM C 478. AS AN ALTERNATE CURING METHOD, THE UNITS MAY BE CURED USING SATURATED STEAM FOR A MINIMUM OF 12 HOURS FOLLOWED BY 6 DAYS OF WATER CURING OR MEMBRANE CURING. IF THE UNITS ARE CURED BY THE ALTERNATE METHOD, THEY SHALL NOT BE SHIPPED PRIOR TO 8 DAYS AFTER CASTING NOR UNTIL THE CONCRETE HAS ATTAINED A STRENGTH OF 3500 PSI (25 MPa).
2. MANHOLE STEPS SHALL CONFORM TO SPPWC 635 TYPE 1 OR 3 OR SPPWC 636. THE MANHOLE STEPS SHALL BE UNIFORMLY SPACED AT A MAXIMUM OF 16" (400 mm). THE LOWEST STEP SHALL BE PLACED NOT LESS THAN 8" (200 mm) NOR MORE THAN 18" (450 mm) ABOVE THE SHELF. THE STEPS SHALL PROJECT 5" (125 mm) INSIDE THE MANHOLE.
3. RISER SECTIONS MAY BE REINFORCED OR UNREINFORCED. REINFORCED SECTIONS SHALL BE REINFORCED IN ACCORDANCE WITH ASTM C 478 AND SHALL HAVE A MINIMUM WALL THICKNESS OF 5" (125 mm). UNREINFORCED RISER SECTIONS SHALL HAVE A MINIMUM WALL THICKNESS OF 6" (150 mm).
4. THE 24"x48" (600 mm x 1200 mm) ECCENTRIC CONES MAY BE REINFORCED OR UNREINFORCED. IF REINFORCED, THE WALL THICKNESS SHALL BE NOT LESS THAN 5" (125 mm). IF UNREINFORCED, THE WALL THICKNESS SHALL NOT BE LESS THAN 6" (150 mm).
5. JOINTS SHALL BE TONGUE AND GROOVE. JOINTS FOR REINFORCED STRUCTURES SHALL CONFORM WITH ASTM C 478 SECTION 14.
6. PRECAST UNITS SHALL BE ASSEMBLED USING CLASS "B" MORTAR.
7. IF 30" (762 mm) DIAMETER MANHOLE FRAME AND COVER IS REQUIRED, IT SHALL BE INSTALLED WHERE THE REDUCER RING IS SHOWN IN THE SECTION.
8. FOR REINFORCED PRECAST STRUCTURES, ALL REINFORCEMENT SHALL HAVE A MINIMUM OF 2" (50 mm) OF COVER OVER THE STEEL ON THE INSIDE FACE.
9. THE TOP OPENING OF THE MANHOLE AND THE STEPS SHALL BE PLACED DIRECTLY OVER THE OUTLET OF THE STRUCTURE EXCEPT AS OTHERWISE NOTED ON PLANS.
10. CONCRETE BASE AND STUB WALLS SHALL BE POURED IN ONE OPERATION TO A POINT 2" (50 mm) ABOVE THE INLET AND OUTLET PIPES. ALL PIPES SHALL BE RIGIDLY SUPPORTED BY TEMPORARY PIERS OR OTHER METHODS DURING THE OPERATION. CONCRETE SHALL SET FOR 24 HOURS BEFORE PLACING PRECAST UNITS.

STANDARD PLANS FOR PUBLIC WORKS CONSTRUCTION

**PRECAST CONCRETE  
SEWER MANHOLE**

STANDARD PLAN

**200-3**

SHEET 2 OF 2



# USC DESIGN GUIDELINES

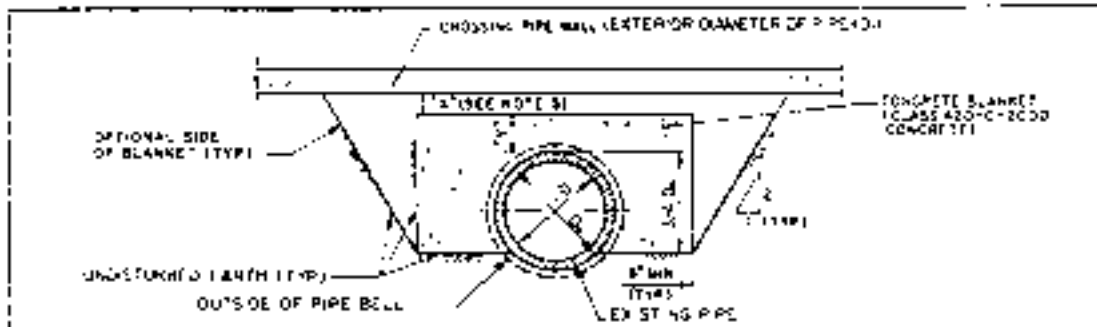
BRICK MAINTENANCE HOLES

PRECAST CONCRETE SEWER MAINTENANCE HOLES

BUREAU OF ENGINEERING		DEPARTMENT OF PUBLIC WORKS		CITY OF LOS ANGELES	
ADJUSTING SEWER MAINTENANCE HOLES TO GRADE				STANDARD PLAN S-137-1	
		NO.	REVISION	DATE	BY

B-4564

# USC DESIGN GUIDELINES

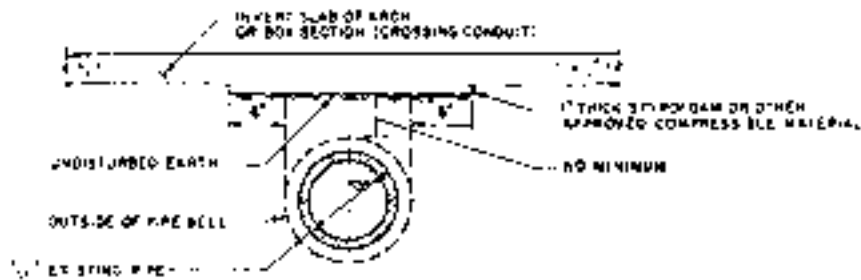


## CONCRETE BLANKET

(FOR EXISTING PIPES CROSSED OVER BY A NEW PIPE)

**NOTES FOR CONCRETE BLANKET:**

1. CONCRETE BLANKET IS REQUIRED WHEN THE CLEARANCE BETWEEN THE TOP OF THE EXISTING PIPE AND THE BOTTOM OF THE CROSSING PIPE IS LESS THAN 18 INCHES.
2. 2" TO 6" THICKNESS MINIMUM WHERE THE CLEARANCE BETWEEN THE TOP OF THE EXISTING PIPE AND THE BOTTOM OF THE CROSSING PIPE IS LESS THAN 12". THE CONCRETE SHALL BE PLACED BETWEEN THE PIPES AND AROUND THE SIDES OF THE CROSSING PIPE UP TO A LEVEL EQUAL TO 1" ABOVE THE EXISTING PIPE, OR AS REQUIRED BY NOTE 3 BELOW, WHICHEVER IS HIGHER.
3. 2" TO 6" MINIMUM TO PROVIDE BEDDING MATERIAL FOR THE CROSSING CONDUIT, WHEN "4" IS LESS THAN THIS MINIMUM, THE ENTIRE TOP SURFACE OF THE BLANKET SHALL EXTEND TO A LEVEL OF 6" TO 8" ABOVE THE BOTTOM OF THE CROSSING PIPE.
4. THE BLANKET SHALL EXTEND LONGITUDINALLY BEYOND THE TRENCH EXCAVATION TO ONE FOOT BEFORE THE FIRST JOINT, EXCEPT THAT THE BLANKET SHALL NOT EXTEND MORE THAN 4 FEET BEYOND EACH SIDE OF THE TRENCH.



## COMPRESSIBLE BLANKET

(FOR EXISTING PIPES CROSSED OVER BY A NEW BOX OR ARCH)

**NOTES FOR COMPRESSIBLE BLANKET:**

1. COMPRESSIBLE BLANKET IS REQUIRED WHEN THE CLEARANCE BETWEEN THE TOP OF THE EXISTING PIPE AND THE BOTTOM OF THE CROSSING CONDUIT (BOX OR ARCH) IS LESS THAN 18 INCHES.
2. THE BLANKET SHALL EXTEND LONGITUDINALLY FOR THE FULL CROSSING CONDUIT TRENCH WIDTH.

BUREAU OF ENGINEERING	DEPARTMENT OF PUBLIC WORKS	CITY OF LOS ANGELES												
<b>BLANKET PROTECTION FOR PIPES</b>		STANDARD PLAN <b>S-255-1</b>												
<p>DATE FIELD: 10/30/15</p> <p>DESIGNED BY: [Signature]</p> <p>CHECKED BY: [Signature]</p> <p>APPROVED BY: [Signature]</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>NO.</th> <th>REASON</th> <th>DATE</th> <th>APPROVED</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>	NO.	REASON	DATE	APPROVED									<p>PROJECT NUMBER: 8-4095</p> <p>SHEET: 1 OF 1</p>
NO.	REASON	DATE	APPROVED											

**USC DESIGN GUIDELINES**

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 33 4000 STORMWATER MANAGEMENT SYSTEMS

### 1. OVERVIEW

- A. University Park Campus (UPC)
  - 1. Purpose: USC preferences and requirements are indicated in this document. For other related requirements, refer to Section 33 41 00 Storm Utility Drainage Piping AND 33 00 00 Order of Inverts.
  - 2. UPC campus is served by City of Los Angeles and County of Los Angeles Public Stormwater System and contains easements.
  - 3. All connections to public stormwater mains and or public catch basins to be coordinated with the appropriate governing agency.
  
- B. Other USC facilities Including Health Science Campus (except Catalina Campus)
  - 1. Purpose: USC preferences and requirements are indicated in this document. For other related requirements, refer to Section 33 41 00 Storm Utility Drainage Piping AND 33 00 00 Order of Inverts.
  - 2. Other USC Facilities are served by City of Los Angeles and/or County of Los Angeles Stormwater System and may contain easements.
  - 3. All connections to public stormwater mains and or public catch basins to be coordinated with the appropriate governing agency.
  
- C. Any work in Catalina Campus to be coordinated with USC.
  
- D. The following table summarizes the types of particular requirements identified within this section for all USC Campuses unless noted otherwise:

## USC DESIGN GUIDELINES

<b>Drainage</b>		
<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Item requiring testing/inspection</b>
<ul style="list-style-type: none"> <li>• Storm Drain main lines and various drainage inlets are owned by either City of Los Angeles or County of Los Angeles</li> <li>• Engineer to research available records associated with public storm drain systems with appropriate governing agency.</li> <li>• Storm drain connection permits issued by the City of Los Angeles or County of Los Angeles are required for connections to main lines, manholes or curb inlet catch basins or modifications to existing catch basins.</li> <li>• 2% max surface slope considering ADA requirements and landscape areas.</li> <li>• Minimum grades for different surfaces               <ul style="list-style-type: none"> <li>➢ Concrete - 0.5%,</li> <li>➢ Asphalt – 1.0%</li> <li>➢ Landscape – 2.0%</li> </ul> </li> <li>• When not possible to meet the minimum slopes listed, coordinate with USC.</li> <li>• Adhere to ADA standards at all times.</li> <li>• Underground storm drainage collection system shall be designed to provide a minimum flow velocity of 3.0 fps. Cut and fill slopes shall not exceed 2:1, unless otherwise approved by University Project Manager and Geotechnical Engineer.</li> <li>• Tracer wire shall be installed on all non-metallic storm drain piping.</li> <li>• Where open air trash enclosure is being installed without a hose bib for washdown, provide catch basin to storm drain. Where washdown will occur, provide dual drain to storm drain and sanitary sewer. Refer to Section 33 3000 for further details.</li> <li>• Private manholes shall have lids that are 30" diameter minimum.</li> </ul>	<ul style="list-style-type: none"> <li>• PVC SDR 35 piping for building storm drain laterals less than 18 inch diameter</li> <li>• Reinforced concrete pipe (RCP) or High Density Polyethylene (HDPE) for 18 inch diameter and over.</li> <li>• Schedule 40 (<i>minimum</i>) P.V.C. pipe with solvent weld joints for sump pump outlets/serving manholes.</li> <li>• Galvanized catch basin grates to prevent rusting.</li> <li>• Catch basin/area drain in lieu of trench drain. If trench drain is necessary, grate must be bolted down.</li> <li>• Design gravity pipes to flow 90% full, without surcharge where possible.</li> </ul>	<ul style="list-style-type: none"> <li>• A water test is required to check for positive drainage.</li> </ul>



## USC DESIGN GUIDELINES

<b>Storm Water Mitigation</b>			
<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed items Listed</b>	<b>Item requiring testing/inspection</b>
<ul style="list-style-type: none"> <li>• All projects that include land-disturbing activity that results in the creation, addition, or replacement of 500 square feet or more of impervious surface area must conform to City of Los Angeles Storm Water Mitigation Requirements or latest approved ordinances.</li> <li>• Storm Water Mitigation system to be reviewed by USC FPM Facilities.</li> <li>• Operation and Maintenance Manuals and Covenants to be provided to USC for all Best Management Practices (BMPs).</li> <li>• Coordinate site specific infiltration testing and requirements with geotechnical engineer, City of Los Angeles Bureau of Sanitation, City of Los Angeles Building &amp; Safety.</li> <li>• Adhere to City and/or County of Los Angeles Low Impact Development Guidelines and mandatory requirements contained in CalGreen Code.</li> </ul>	<ul style="list-style-type: none"> <li>• Storm Water Mitigation systems with the lowest impact to the surrounding campus.</li> <li>• Storm Water Mitigation systems that can be easily maintained, as agreed with USC FPM Facilities .</li> <li>• Refer to CA Stormwater BMP Manual.</li> <li>• Deep infiltration under areas subject to vehicular loading</li> </ul>	<p>N/A</p>	<ul style="list-style-type: none"> <li>• All Storm Water Mitigation systems to be properly inspected by civil engineer of record and City of Los Angeles.</li> <li>• All infiltration systems to be tested for proper percolation upon completion of construction and reviewed by civil engineer of record.</li> </ul>

### **Storm Water Pollution Prevention**

## USC DESIGN GUIDELINES

Requirements Listed	Preferences Listed	Disallowed items Listed	Item requiring testing/inspection
<ul style="list-style-type: none"> <li>• For projects less than 1 acre, an approved Erosion Control Plan from City of Los Angeles/ Other Appropriate Governing Agency.</li> <li>• State SWPPP for all projects 1 acre or more</li> <li>• If SWPPP required, a state certified Civil Engineer or other Consultant to serve as QSD</li> <li>• If SWPPP required, USC representative with signatory powers to serve as LRP</li> <li>• If SWPPP required, USC to hire QSP</li> <li>• Contractor to conform to current SWPPP requirements</li> </ul>	<ul style="list-style-type: none"> <li>• QSD to coordinate with USC on SMARTS system information input.</li> </ul>	<p>N/A</p>	<ul style="list-style-type: none"> <li>• Testing and inspection for pre, post and during rain events as required by the construction general permit.</li> </ul>

## USC DESIGN GUIDELINES

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section: Drainage
1. Required:
    - a) Space consideration for potential infiltration on project site.
    - b) Design to a 25-year storm frequency and 50-year in Sump Condition. Adhere to the LA County Hydrology Manual.
    - c) Engineer to research available records associated with public storm drain systems with appropriate governing agency.
    - d) Storm drain connection permits issued by the City of Los Angeles or County of Los Angeles are required for connections to main lines, manholes or curb inlet catch basins or modifications to existing catch basins.
    - e) Underground storm drainage collection system shall be designed to provide a minimum flow velocity of 3.0 fps. Cut and fill slopes shall not exceed 2:1, unless otherwise approved by University Project Manager and Geotechnical Engineer.
    - f) Private storm drain manhole lids shall be 30" in diameter minimum.
  2. Preferred:
    - a) Grading to minimize drain inlets.
    - b) Design gravity pipes to flow 90% full, without surcharge where possible.
- B. Design considerations specific to components in this section: Storm Water Mitigation
1. Required:
    - a) Space consideration for potential infiltration on project site.
    - b) All projects that include land-disturbing activity that results in the creation, addition, or replacement of 500 square feet or more of impervious surface area must conform to City of Los Angeles Storm Water Mitigation/Low Impact Development Requirements.
    - c) Storm Water Mitigation system to be reviewed by USC FPM Facilities.
    - d) Operation and Maintenance Manuals and Covenants to be provided to USC for all Best Management Practices (BMPs).
    - e) Coordinate site specific infiltration testing and requirements with geotechnical engineer, City of Los Angeles Bureau of Sanitation, City of Los Angeles Building & Safety.
    - f) Adhere to City and/or County of Los Angeles Low Impact Development Guidelines and mandatory requirements contained in CalGreen Code.
  2. Preferred:
    - a) Storm Water Mitigation systems with the lowest impact to the surrounding campus.
    - b) Deep infiltration, such as dry wells, under areas subject to vehicular traffic.
    - c) Storm Water Mitigation systems that can be easily maintained, as agreed with USC FPM Facilities. Preference shall be given to system types already installed on campus. Please provide access point, such as maintenance hole, for cleaning purposes.
    - d) Refer to CA Stormwater BMP Manual.

## USC DESIGN GUIDELINES

- C. Design considerations specific to components in this section: Storm Water Pollution Prevention
1. Required:
    - a) For projects less than 1 acre, an approved Erosion Control Plan from City of Los Angeles/ Other Appropriate Governing Agency.
    - b) State SWPPP for all projects 1 acre or more.
    - c) If SWPPP required, a state certified Civil Engineer or Other Consultant to serve as QSD.
    - d) If SWPPP required, USC representative with signatory powers to serve as LRP.
    - e) If SWPPP required, USC to hire QSP.
    - f) Contractor to conform to current SWPPP requirements.
  2. Preferred:
    - a) QSD to coordinate with USC on SMARTS system information input.

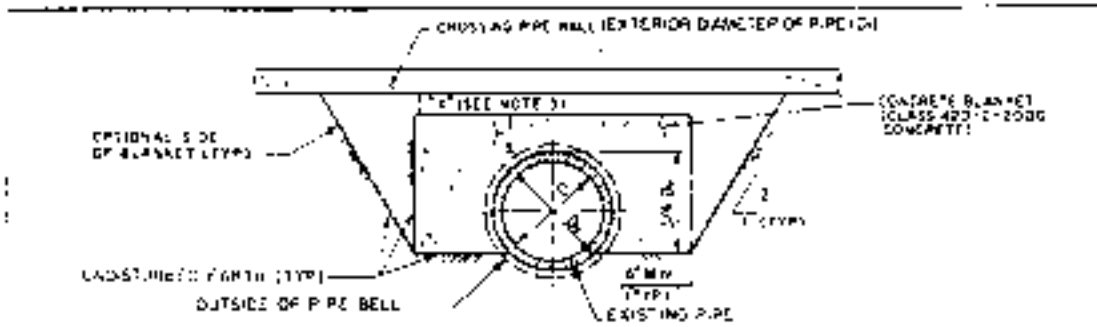
### 3. INSTALLATION REQUIREMENTS

- A. Required:
1. 3' minimum cover over pipes.
  2. Blanket protection over pipe if 3' minimum cover unachievable. Refer to City of Los Angeles Public Works Standard Detail S-255-I
  3. Refer to City of Los Angeles Standard Plans, Standard Specifications for Public Works Construction "Greenbook" and typical installation details (see below) where appropriate. Confirm installation details are most current.
  4. Tracer Wire: Install continuous length of tracer wire for full length of each run of non-metallic pipe. Fasten wire to top of pipe in such a manner that it will not be displaced during construction operations. Wire shall be fastened to pipe at intervals not exceeding 20 feet. Wire shall terminate at surface in an in ground traffic rated access box labeled "storm" directly adjacent to a private manhole, cleanout or junction structure.
  5. 2% max surface slope considering ADA requirements and landscape areas.
  6. Minimum grades for different surfaces.
    - a) Concrete – 0.5%,
    - b) Asphalt – 1 %,
    - c) Landscape – 2.0 %.
  7. When not possible to meet the minimum slopes listed, coordinate with USC.
  8. Adhere to ADA standards at all times.
  9. Repair disturbed pavement per University requirements. Replace affected pavement to match existing at minimum unless otherwise noted.
- B. Preferred:
1. Design gravity pipes to flow 90% full, without surcharge where possible.
  2. PVC SDR 35 piping for building storm drain laterals less than 18 inch diameter
  3. Reinforced concrete pipe (RCP) or High Density Polyethylene (HDPE). 18 inch diameter and over.
  4. Schedule 40 (*minimum*) P.V.C. pipe with solvent weld joints for sump pump outlets/serving manholes.
  5. Galvanized catch basin grates to prevent rusting.

## **USC DESIGN GUIDELINES**

6. Catch basin/area drain in lieu of trench drain. If trench drain is necessary, grate must be bolted down.

# USC DESIGN GUIDELINES

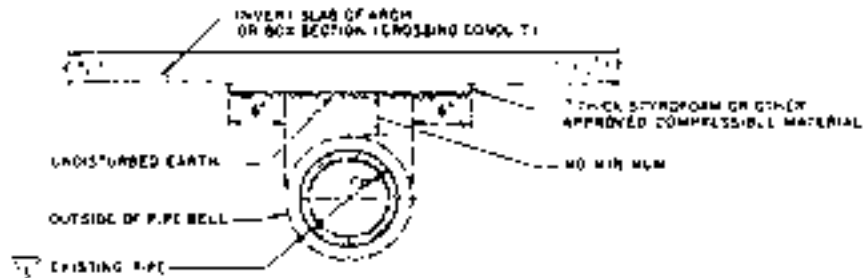


## CONCRETE BLANKET

(FOR EXISTING PIPES CROSSED OVER BY A NEW PIPE)

**NOTES FOR CONCRETE BLANKET:**

- 1. CONCRETE BLANKET IS REQUIRED WHEN THE CLEARANCE BETWEEN THE TOP OF THE EXISTING PIPE AND THE BOTTOM OF THE CROSSING PIPE IS LESS THAN 18 INCHES.
- 2. IF THE CLEARANCE BETWEEN THE TOP OF THE EXISTING PIPE AND THE BOTTOM OF THE CROSSING PIPE IS LESS THAN 18", THE CONCRETE SHALL BE PLACED BETWEEN THE PIPES AND AROUND THE SIDES OF THE CROSSING PIPE TO A LEVEL EQUAL TO 1" ABOVE THE EXISTING PIPE, OR AS REQUIRED BY NOTE 3 BELOW, WHICHEVER IS HIGHER.
- 3. IF THE MINIMUM TO PROVIDE BEDDING MATERIAL FOR THE CROSSING CONDUIT WHEN "X" IS LESS THAN THIS MINIMUM, THE ENTIRE TOP SURFACE OF THE BLANKET SHALL EXTEND TO A LEVEL OF 0.125' ABOVE THE BOTTOM OF THE CROSSING PIPE.
- 4. THE BLANKET SHALL EXTEND LONGITUDINALLY BEYOND THE TRENCH FACE(S) TO ONE FOOT BEFORE THE FIRST PIPE JOINT (FACE) THAT THE BLANKET NEED NOT EXTEND MORE THAN 4 FEET BEYOND EACH SIDE OF THE TRENCH.



## COMPRESSIBLE BLANKET

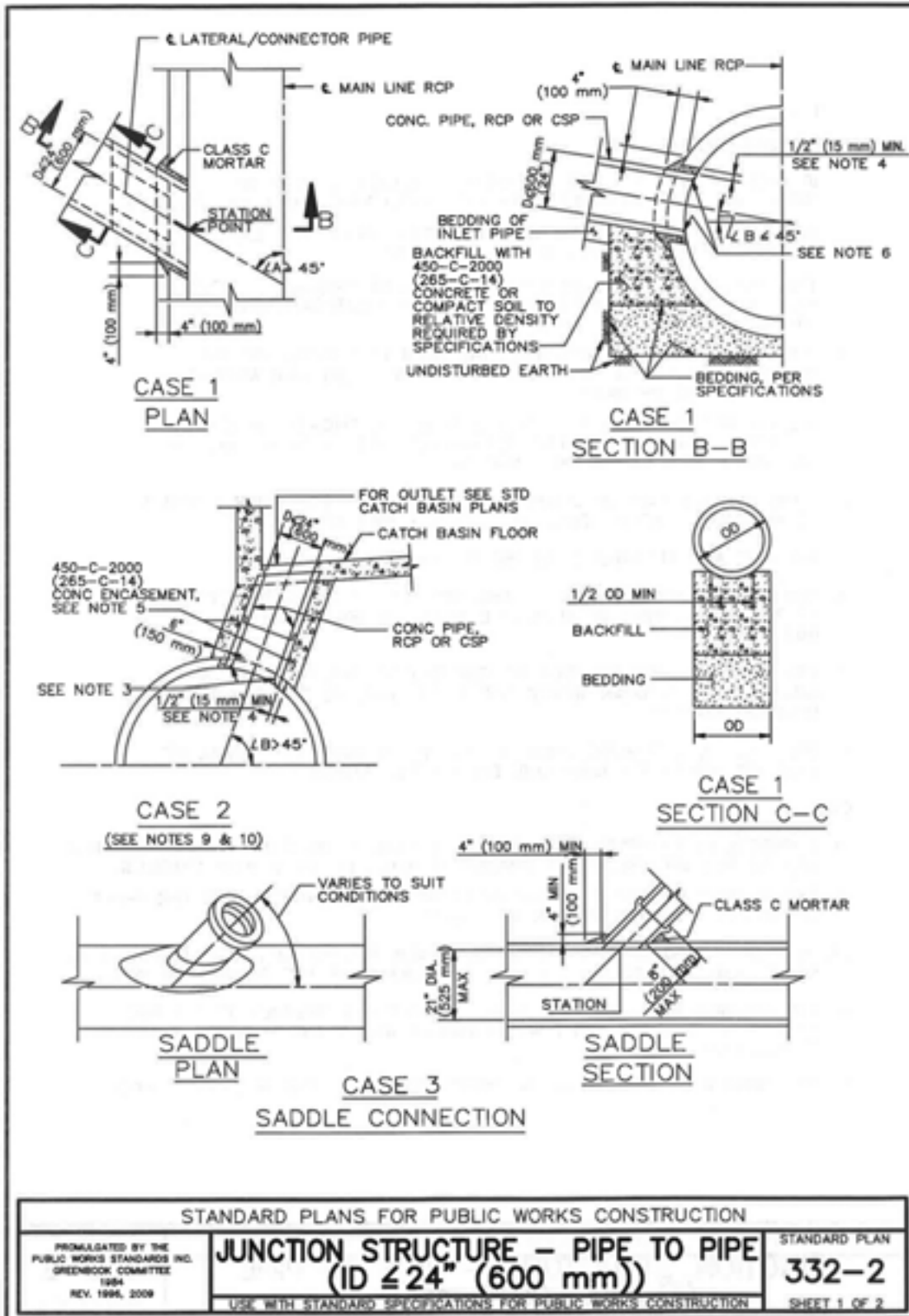
(FOR EXISTING PIPES CROSSED OVER BY A NEW BOX OR ARCH)

**NOTES FOR COMPRESSIBLE BLANKET:**

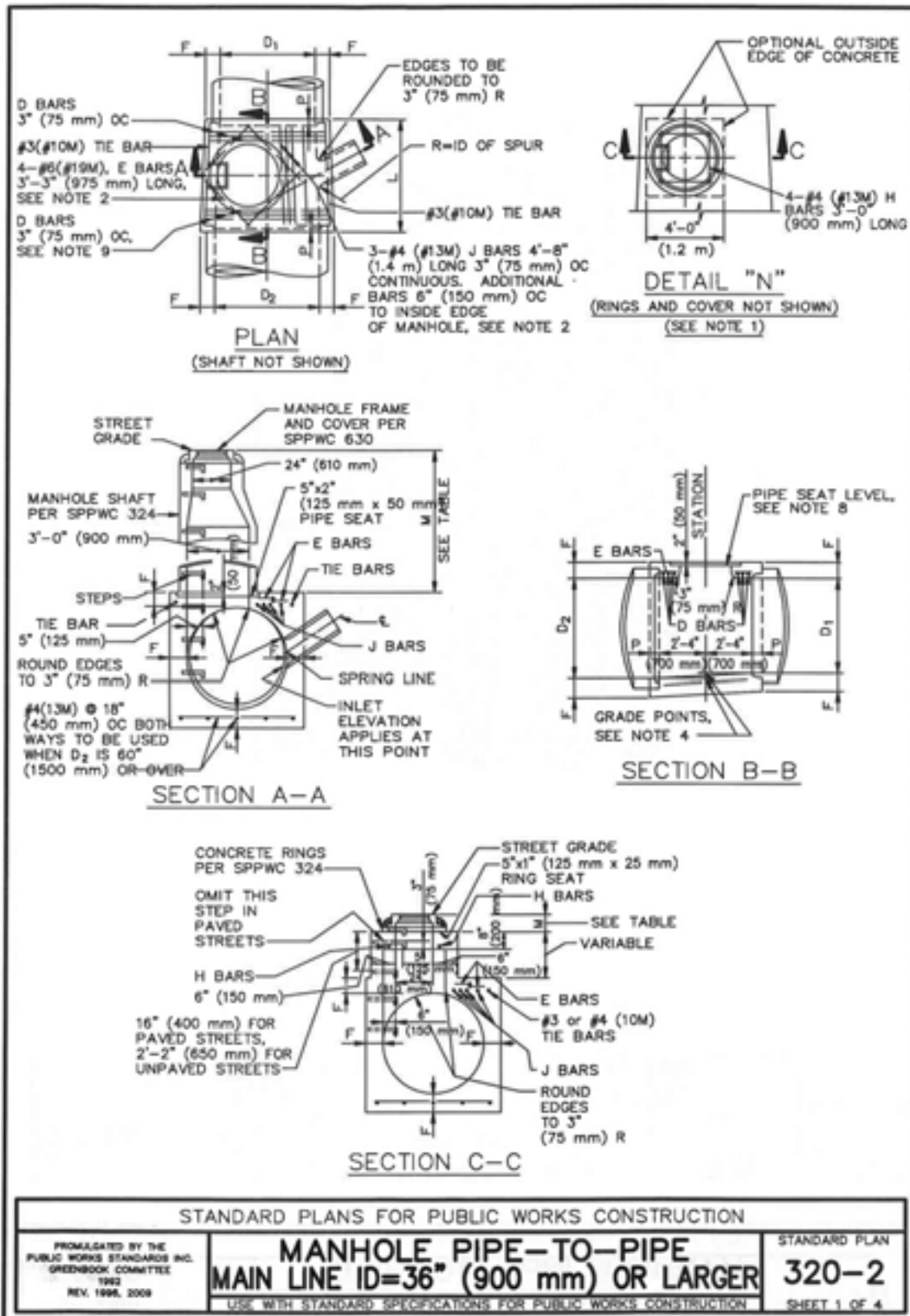
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- 2. THE BLANKET SHALL EXTEND LONGITUDINALLY FOR THE FULL CROSSING CONDUIT TRENCH WIDTH.

BUREAU OF ENGINEERING	DEPARTMENT OF PUBLIC WORKS	STANDARD PLAN S-255-1
<b>BLANKET PROTECTION FOR PIPES</b>		SUPERVISOR: [Signature] # 1980
DATE: 1901 [Signature] [Signature]	REVISION NO. 1 [Signature] [Signature]	SHEET NO. 1 OF 1 SECTION

# USC DESIGN GUIDELINES

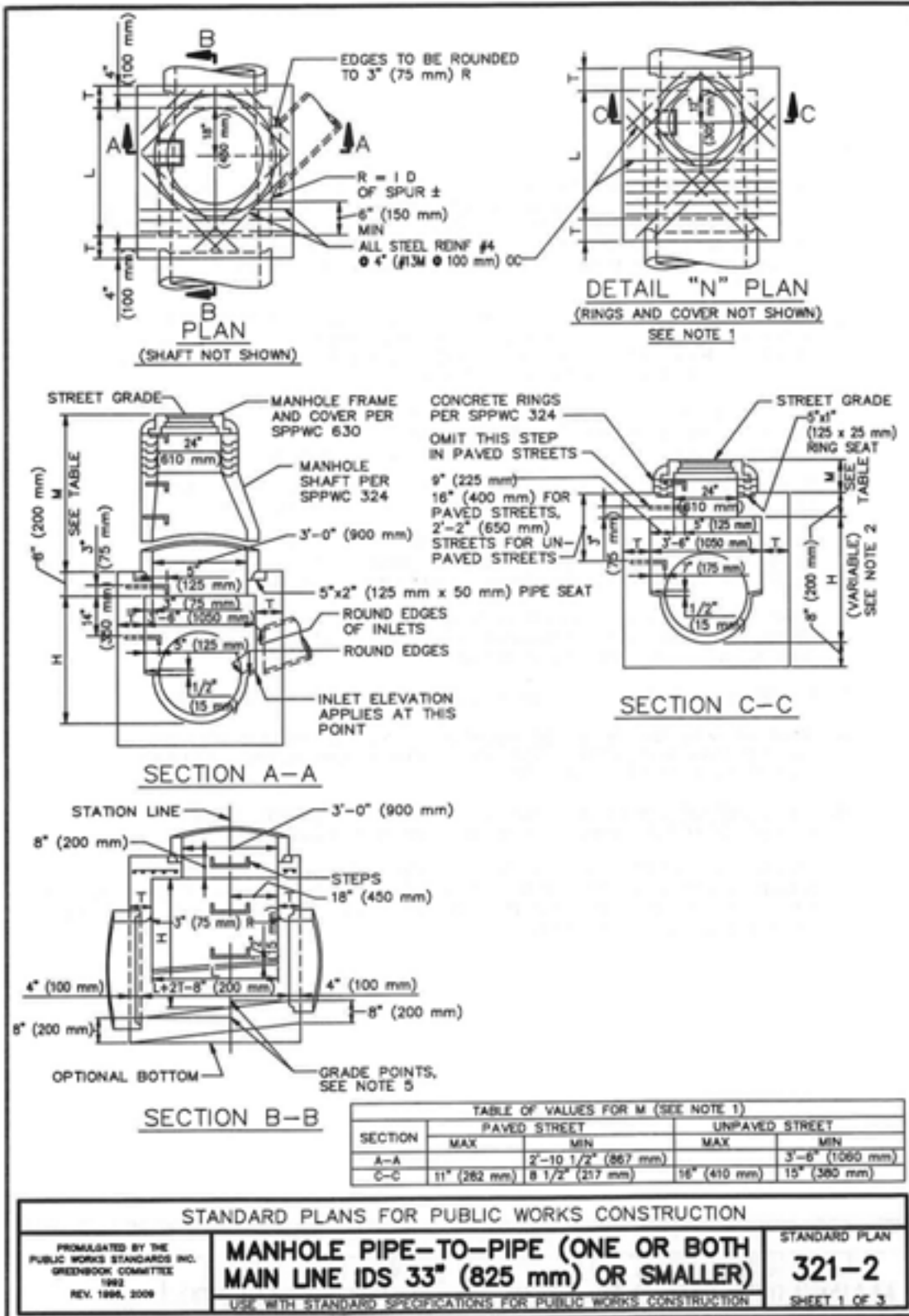


# USC DESIGN GUIDELINES

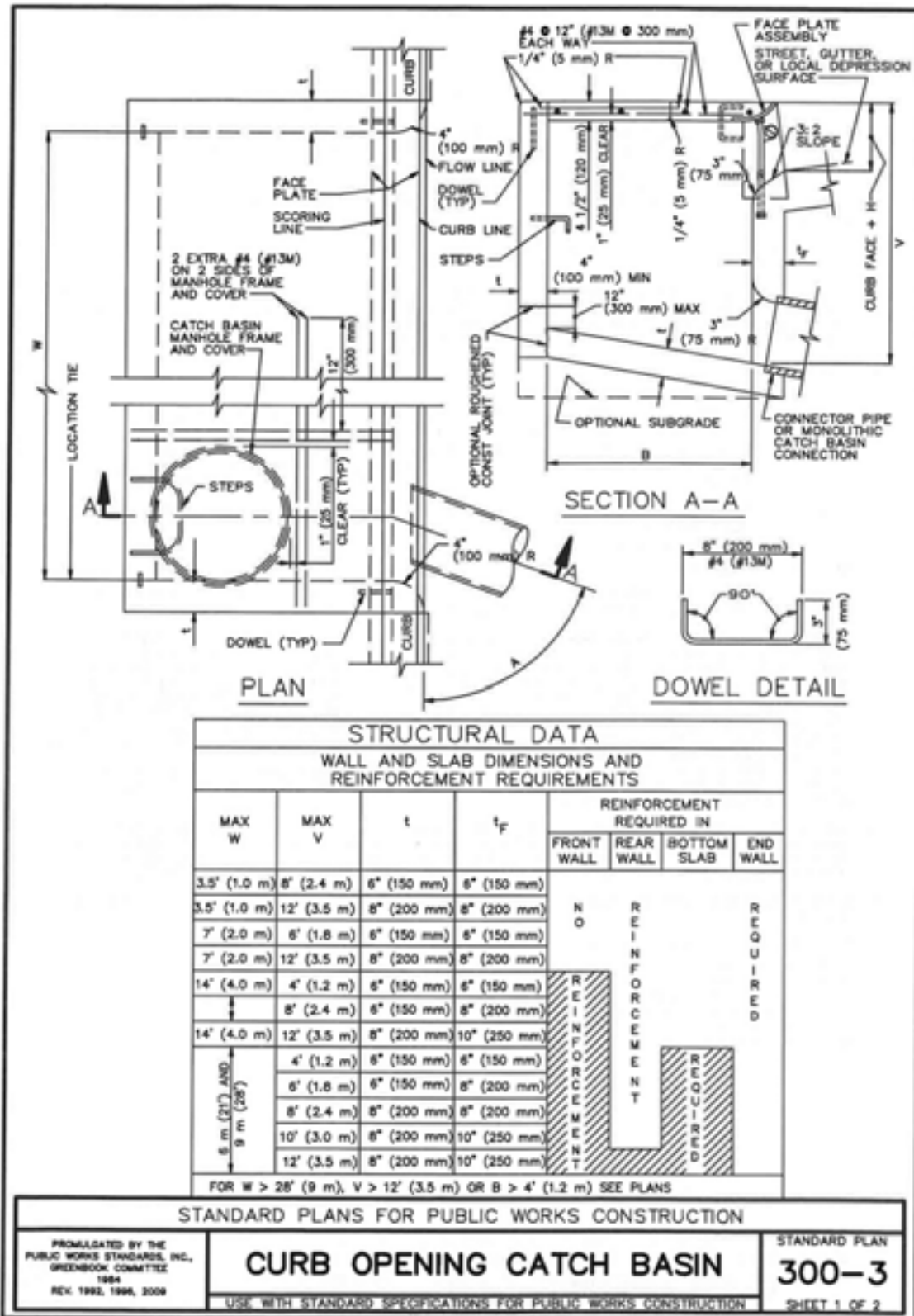




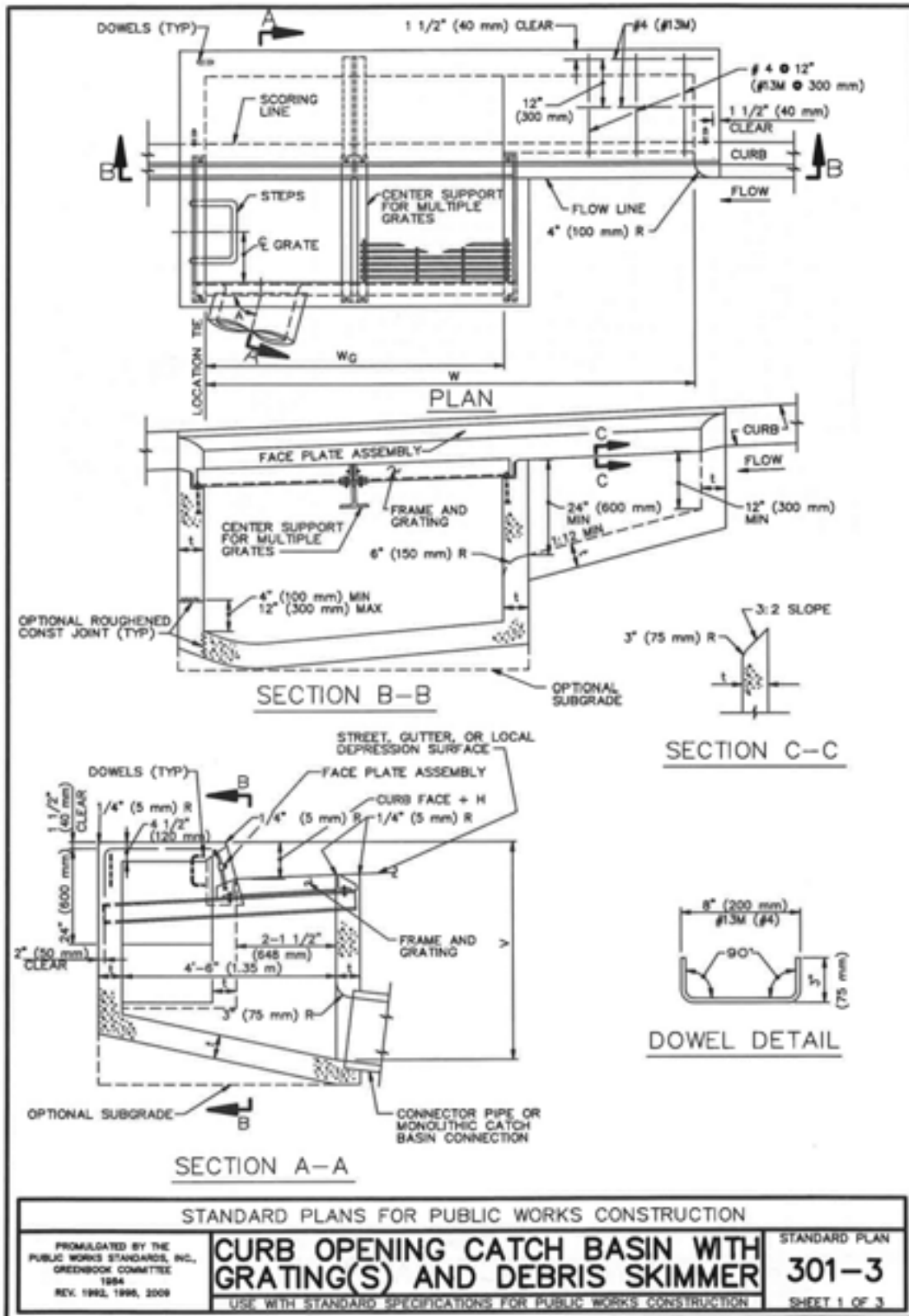
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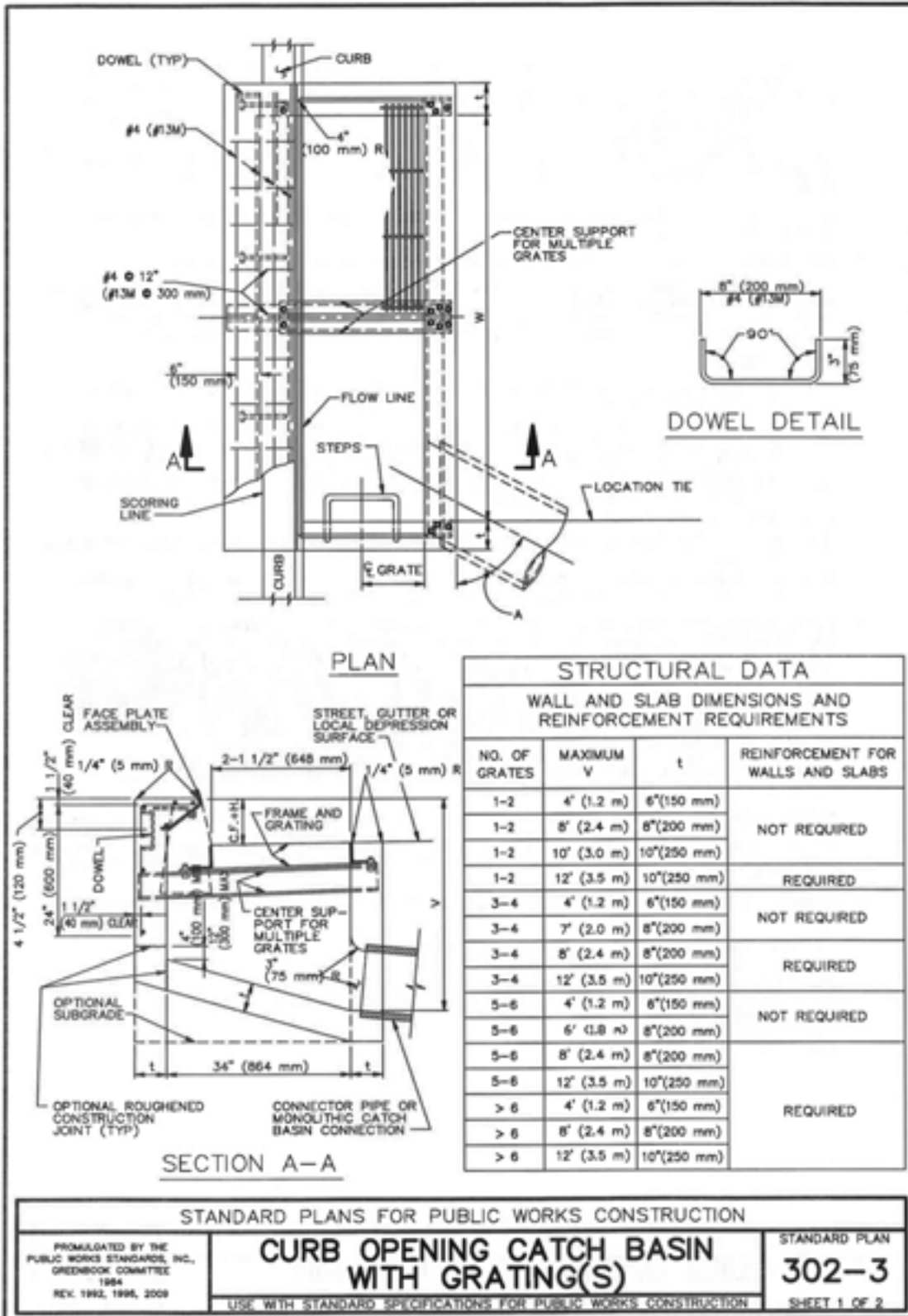
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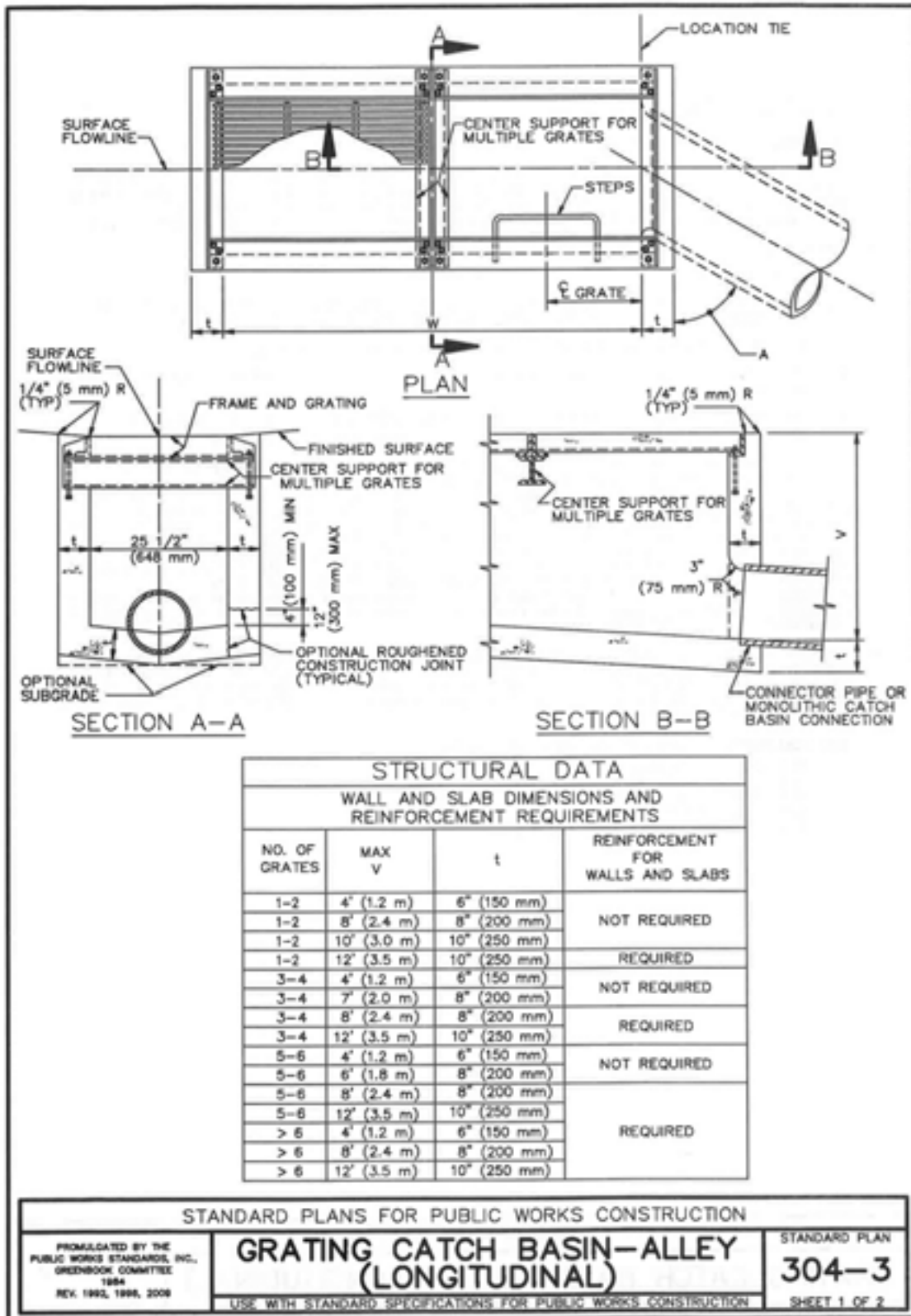
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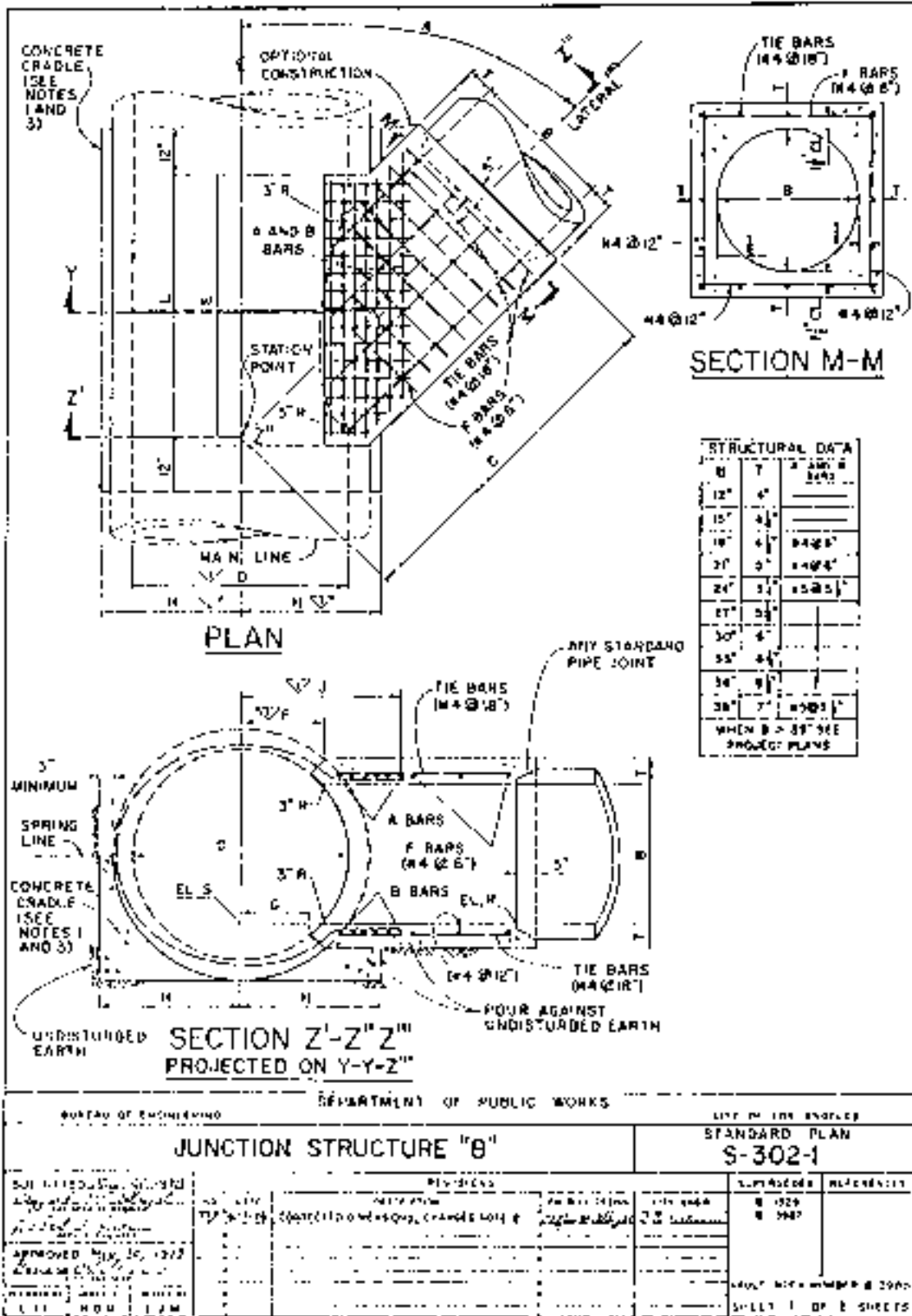
# USC DESIGN GUIDELINES



# USC DESIGN GUIDELINES



# USC DESIGN GUIDELINES



BUREAU OF ENGINEERING		DEPARTMENT OF PUBLIC WORKS		LIST IN THE END OF	
JUNCTION STRUCTURE "B"			STANDARD PLAN		
			S-302-1		
SUBMITTED BY: [Signature] DATE: [Date]	REVIEWED BY: [Signature] DATE: [Date]	APPROVED BY: [Signature] DATE: [Date]	SUPERSEDES: [List] REFERENCES: [List]	SHEET NO. [Number] OF [Total] SHEETS	[Additional notes or signatures]



**USC DESIGN GUIDELINES**

**END OF DOCUMENT**



# USC DESIGN GUIDELINES

## 33 5100 NATURAL GAS DISTRIBUTION

### 1. OVERVIEW

#### A. University Park Campus (UPC)

- I. Purpose: USC preferences and requirements are indicated in this document. For other related requirements, refer to Section 22 70 00 AND 33 00 00 Order of Inverts.
- II. The campus is supplied with natural gas at 40-60 P.S.I by the local gas company. There are two gas distribution systems, one serving all building sites at 10 P.S.I., the other serves the Central Heating Plant co-generation unit 40-60 P.S.I. **- TO BE VERIFIED BY USC**
- III. All connections to the gas mains owned and operated by the gas company to be coordinated with the gas company. All proposed gas meters to be coordinated with gas company.
- IV. Easements associated with existing, proposed and relocated gas mains to be coordinated with the gas company. All legal descriptions of said easements to be written by University approved California Licensed Land Surveyor.

#### B. Other USC Facilities Including The Health Science Campus (except Catalina Campus)

- I. Purpose: USC preferences and requirements are indicated in this document. For other related requirements, refer to Section 22 11 00 AND 33 00 00 Order of Inverts.
- II. Other USC Facilities are served by the local gas company.
- III. All connections to the gas mains owned and operated by the gas company to be coordinated with the gas company. All proposed gas meters to be coordinated with gas company.

#### C. Any work in Catalina Campus to be coordinated with USC.

## USC DESIGN GUIDELINES

- D. The following table summarizes the types of particular requirements identified within this section for all USC Campuses unless noted otherwise:

<b>Natural Gas Distribution (TO BE VERIFIED BY USC)</b>		
<b>Requirements Listed</b>	<b>Preferences Listed</b>	<b>Disallowed Items Listed</b>
The existing campus gas distribution system is coated steel piping and protected from electrolysis by a low voltage cathodic protection system.		
All additions to the existing system shall be with approved plastic gas piping and no underground steel piping will be acceptable.		
Gas Connection Permit to be obtained from the local gas company.		
All connections to be per gas company's standards at a minimum unless approved.		
Engineer to confirm with the gas company regarding pipe material for connection to gas mains.		
Engineer to research available records associated with gas mains with the gas company.		
Prior to all construction, conduct a safety meeting with the Contractor, sub-contractor, project manager, Fire Safety, and an FPM Facilities plumbing representative. Meeting to include history of past gas related incidents, cause and prevention.		
For new gas line construction, install warning tape 12" above the line.		

## USC DESIGN GUIDELINES

For suspected existing gas line locations, Contractor is to hand dig in these areas.		
Contractor to obtain Hotwork permits from Fire Safety for all Hotwork operations.		
If an incident occurs, there needs to be a response team in place including the contractor, sub-contractor, project manager, Fire Safety and an FPM Facilities plumbing representative that will meet at the location of the incident.		

## USC DESIGN GUIDELINES

### 2. PROCEDURAL REQUIREMENTS (TO BE VERIFIED BY USC)

#### A. Design considerations specific to components in this section:

##### 1. Required:

- a) Valves shall be steel body, lubricated plug type with a minimum working pressure equal to 200 P.S.I.. Valves shall have 2" square operating nut and extensions shall be provided as required to bring the operating nut within 6" of the top of the valve box. Valves shall be lubricated before they are put into service. Provide system sectionalizing valves as required.
- b) Valve boxes shall be similar to the water boxes above, be triangular in shape, and be embossed with the word "GAS" on the top surface.
- c) Meters reading in cubic feet of gas per hour and provided with a pulse contact for connection to the Energy Management System (EMS) shall be provided for the following building classifications:
  - Academic Buildings
  - Housing
  - Food Service
  - Other areas as determined for specific projects
- d) All new gas services to be processed with the gas company's "Request for Non-Residential Gas Facilities". See form below.

##### 2. Preferred:

- a) None

##### 3. Disallowed:

- a) None



## USC DESIGN GUIDELINES

### 3. INSTALLATION REQUIREMENTS (TO BE VERIFIED BY USC)

- A. Required:
  - 1. A building served from the 40-60 P.S.I. system must be installed with a double P.R.V. station.
  - 2. A tracing wire shall be installed with all underground gas pipe.
  - 3. An underground warning tape shall be provided in all pipe trenches.
  - 4. All installation shall comply with NFPA 54.
  - 5. Repair disturbed pavement per University requirements. Replace affected pavement to match existing at minimum unless otherwise noted.
- B. Preferred:
  - 1. None

### 4. TESTING or INSPECTION (TO BE VERIFIED BY USC)

- A. List of items or systems requiring testing, evaluation, verification, or commissioning:  
New piping systems, existing piping systems that have been altered/ extended/  
repaired:
- B. Required testing protocols:
  - 1. Leak and Defect testing, test and inspect per authorities having jurisdiction.
  - 2. Pressure test pipe with air to 100 P.S.I.G. for 4 hours min.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 33 6000 HYDRONIC AND STEAM UTILITIES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 23 00 00, 23 05 16, 23 07 19, 23 21 13, 23 22 13 and 33 00 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		

- D. This section relates to the following: Campus Site Utilities

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) Any building on the University Park Campus (UPC) or Health Sciences Campus (HSC) shall be connected to the University Utilities available in the area. This must be coordinated with FPM Facilities Engineering. A formal request must be made by the design team to FPM Facilities Engineering by Schematic Design to see what University utilities are available in the area. The request must include an estimated building utility load for each utility in the form of a chart as follows:

Service	Capacity required by building	Performance Characteristics	FPM Facilities Comments
Chilled Water from USC plant	_____ tons (to be filled in by design team)	UPC operates at 45°F supply and 65°F Return A differential of 20°F from the building is required. HSC operates at 44°F supply and 60°F Return A differential of 20°F from the building is required	Hours of Operation = 24 hours Pressure drop not to exceed 10 psi across the building
Steam from USC plant	_____ lb/hr (to be filled in by design team)	UPC steam plants operate at 12-15 psig supply	Available Supply Pressure at building sites will be 8-10psi. Hours of Operation = 24 hours
Steam condensate returned to USC plant	_____ lb/hr		Back-pressure required to be achieved at site will be 45 psi. Pumping head must get flow back to the local receiving station Hours of Operation = 24 hours

## USC DESIGN GUIDELINES

- b) For underground utilities, maintain a minimum coverage of 36" from top of pipe to finished grade directly above. Exceptions shall be considered on a case by case basis, based on the contractor submitting proof of need and appropriate measures for approval to ensure proper load distribution for anticipated vehicular traffic.
- c) Underground piping systems shall be pre-engineered. Calculations and details for expansion control and anchorage design shall be done by a licensed engineer and submitted to FPM Engineering prior to 100% Design Development.
- d) Straight lengths of steam, steam condensate and heating hot water underground piping are to be furnished with factory end seals, matching the jacket material.
- e) Only 90 degree fittings/transitions shall be used for steam piping, and the elbows shall be of long-radius type and shall be factory pre-insulated.
- f) All underground elbows to be utilized for steam, steam condensate and heating hot water systems shall be factory pre-insulated. The contractor shall allocate enough time to accommodate lead-times associated with procurement of pre-insulated elbows.
- g) Pre-fabricated buried piping provided by this Section shall extend into the building through a Link-seal penetration provided under sections 23 2113 and 23 2213. This Section shall be responsible to provide anchorage and expansion control as per 23 0516 and to coordinate with the Building Engineer to ensure that no undue forces are transmitted into the building structures without proper and detailed analytical coordination.
- h) References to observation/witness by FPM Facilities throughout this section are additional to observations from engineer of record, and approvals from AHJ inspectors of record. FPM Facilities review does not alleviate the contractor from attaining these installation approvals.
- i) Owner to retain third party Inspector of Record to provide continuous inspection of the installation of underground hydronic and steam utilities to include, but not limited to:
  - 1) Materials delivered to site
  - 2) Contractor welding certifications
  - 3) Welding process
  - 4) Field applied insulation
  - 5) Field joint closure work
  - 6) Concrete anchors
  - 7) Slope of system
  - 8) Repair of any coatings
  - 9) Pressure testing
  - 10) Backfill in contact with pipe jackets.
- j) Contractor shall submit specific plan for pre-operational cleaning strategy for review. This shall include steps and temporary measures required to separate and address new versus existing piping (where applicable).
  - 1) Pre-operational cleaning plan should also take into account the implications of pressure testing (as covered under separate sections) and the goal to avoid stagnant water or corrosion in hydronic pipe systems which are not to be placed into operation immediately



## USC DESIGN GUIDELINES

2. Preferred:
  - a) Maintain pipe inverts per 33 0000.
  - b) Provide back fill per 33 0000. Alternatives shall be considered on a case by case basis and only if field conditions pose significant challenges to meeting the above.
3. Disallowed:
  - a) No 45 degree fittings/transitions are allowed for steam piping.
  - b) Field insulated elbow fittings for steam, steam condensate and heating hot water systems.
  - c) Concrete slurry backfill.
  - d) Carrier pipe leak testing by means of compressed air.

B. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS

A. Underground Pre-Fabricated, Pre-Engineered, Pre-Insulated piping:

1. Manufacturers:
  - a) Required: (Chilled Water, Heating Hot Water and Steam Condensate):
    - 1) Thermacor Process Inc. FERRO-THERM
    - 2) Rovanco HDPE Jacketed System
    - 3) Perma-Pipe XTRU-THERM
  - b) Required: (Steam):
    - 1) Perma-Pipe Multi-Therm 750 PE
    - 2) Rovanco Insul-800
2. Component Characteristics:
  - a) Required:
    - 1) Provide the following materials for piping and fittings:

Service	Material: Carrier pipe	Joining Method
Chilled Water	ASTM A53 Type E Schedule 40 Black Steel Domestic Source	Welded
Heating Hot Water	ASTM A53 Type E Schedule 40 Black Steel Domestic Source	Welded
Steam	ASTM A53 Type S (Seamless) Schedule 40 Black Steel Domestic Source	Welded
Steam Condensate	ASTM A53 Type E Schedule 80 XS (Extra Strong) Black Steel Domestic Source	Welded

Service	Material: Conduit	Joining Method
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## USC DESIGN GUIDELINES

Service	Material: Conduit	Joining Method
Steam	ASTM A139 Spiral 10 Gauge. Galvanized Steel	Welded

- 2) Carbon steel piping shall comply with ASTM/ANSI standards.
- 3) All carbon steel pipe shall have ends cut square and beveled for butt-welding. Straight sections of factory insulated pipe shall have 6" of exposed pipe at each end for field joint fabrication. Provide HDPE end seals at straight lengths of piping.
- 4) Chilled Water, Heating Hot Water, Steam Condensate Pipe: Insulation shall be polyurethane foam either spray applied or high pressure injected with one shot into the annular space between carrier pipe and jacket. Insulation shall be rigid, 90% minimum closed cell polyurethane with a minimum 2.0 lbs. per cubic foot density, compressive strength of 30 psi, and coefficient of thermal conductivity (K- Factor) of not higher than 0.16 @ 75°F per ASTM C-518. Insulation shall be suitable for use and should be guaranteed to not degrade at a maximum operating temperature of 250°F.
- 5) Steam Pipe: Insulation for the carrier pipe shall be minimum 0.591" thick Pyrogel XT. Conduit insulation shall be minimum 1" thick, 90% minimum closed cell polyurethane with a minimum 2.0 lbs. per cubic foot density, compressive strength of 30 psi, and coefficient of thermal conductivity (K- Factor) of not higher than 0.16 @ 75°F per ASTM C-518.
- 6) Steam Pipe: All underground piping and fittings shall be furnished with factory installed wire leak detection system embedded in the conduit insulation.
- 7) Jacketing material shall be extruded, black, high density polyethylene (HDPE), having a minimum wall thickness not less than 100 mils for pipe sizes less than or equal to 12", 125 mils for jacket sizes larger than 12" to 24", and 150 mils for jacket sizes greater than 24". No tape jacket allowed. The inner surface of the HDPE jacket shall be oxidized. This will ensure a secure bond between the jacket and foam insulation preventing any ingress of water at the jacket/foam interface.
- 8) Steam piping conduit system shall be testable, drainable and dryable. Provide vent and drain piping at gland seal/end seals located at pipe penetrations that daylight in manholes and buildings.
- 9) Provide the following piping grade or slope for complete drainage and venting:

Piping Type	Slope	Direction of Fall
Chilled Water and Condenser Water	1" per 40'-0"	Down in direction of flow
Cold condensate	1" per 40'-0"	Down in direction of flow
Steam (main)	1" per 40'-0"	Down in direction of flow

## USC DESIGN GUIDELINES

Piping Type	Slope	Direction of Fall
Steam Condensate	1" per 40'-0"	Down in direction of flow

- 10) Provide the following types of exterior jacketing for pre-fabricated piping:

System	Pipe Size	Jacket Type	Comments
Steam (outer conduit)	All	HDPE	Including elbows.
Steam Condensate	All	HDPE	Including elbows.
Heating Hot Water	All	HDPE	
Chilled Water	<12"	HDPE	
	≥12"	HDPE	

- 11) Straight run joints shall be field-insulated per the manufacturer's instructions, using polyurethane foam poured in an HDPE sleeve and sealed with a heat shrink sleeve.
- 12) Straight run joints shall be provided with HDPE end seals.
- 13) Fittings are factory pre-fabricated and pre-insulated fittings with polyurethane foam to the thickness specified and jacketed with a one-piece seamless molded HDPE fitting cover, a butt fusion welded, or an extrusion welded and mitered HDPE jacket. Carrier pipe fittings shall be butt-welded, except sizes smaller than 2" shall be socket-welded.
- 14) Expansion/contraction compensation will be accomplished utilizing factory pre-fabricated and pre-insulated expansion elbows, Z-bends, expansion loops, and anchors specifically designed for the intended application. External expansion compensation utilizing flexible expansion pads (minimum one inch thickness), extending on either side, both inside and outside the radius of the fittings are used with all fittings having expansion in excess of 1/2".
- 15) It is required for underground installations to provide prefabricated fittings, valves, and accessories.
- b) Required::
- 1) Prefabricated/Pre-insulated underground fittings.
- c) Disallowed:
- 1) Field-applied insulation of underground fittings is not allowed unless explicitly approved by FPM Facilities on a case by case basis, to address unforeseen field conditions only.
  - 2) Mechanical subcontractors may not perform field insulation work at fittings: an insulation subcontractor must be engaged to do field insulation underground.

## USC DESIGN GUIDELINES

- 3) Copper piping shall not be used.

### 4. INSTALLATION

#### A. Required:

1. Provide the following piping grade or slope for complete drainage and venting for both above ground and underground piping:

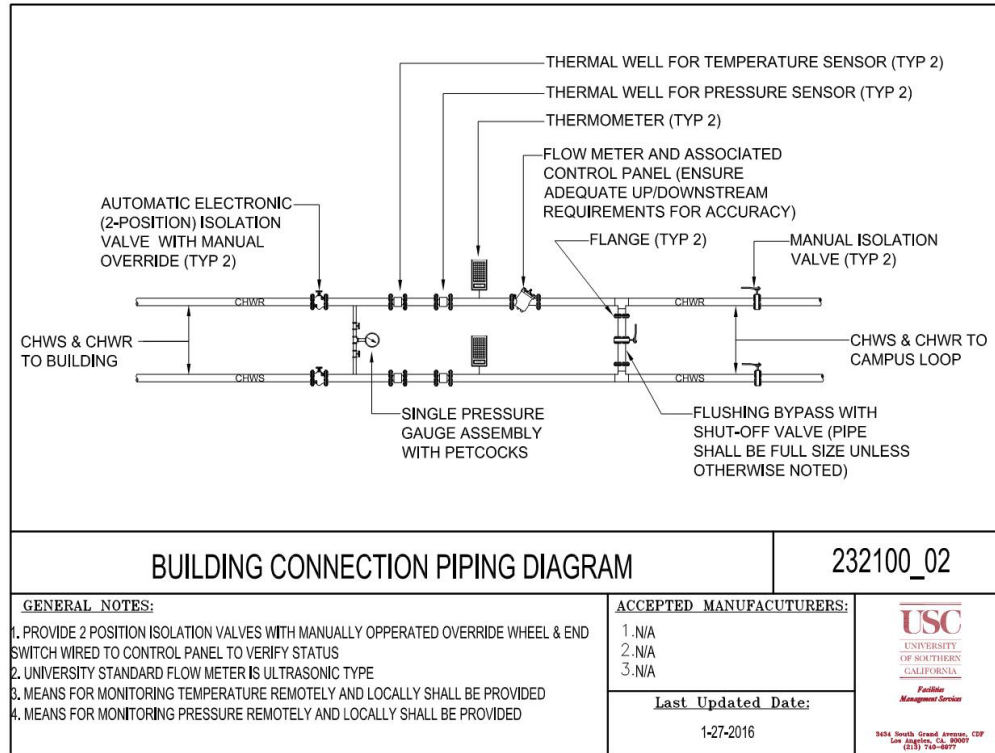
Piping Type	Slope	Direction of Fall
Chilled Water and Condenser Water	1" per 40'-0"	Down in direction of flow
Cold condensate	1" per 40'-0"	Down in direction of flow
Steam (main)	1" per 40'-0"	Down in direction of flow
Steam Condensate	1" per 40'-0"	Down in direction of flow

2. Install piping systems parallel to building walls and nearby constructions.
3. Maintain piping within or distributed through building equipment rooms exposed and not concealed within or imbedded into Architectural/Structural systems (wall, floors, etc.)
4. Provide right angle (90°) fittings for changes of direction in the horizontal plane.
5. Provide industry standard pre-manufactured fittings for all piping distribution system changes in direction, changes in size, branch connections, or at final equipment connections.
  - a) Where pre-manufactured fittings cannot be accommodated, and field welding is necessary, contractor shall coordinate FPM Facilities to observe a sampling of these installations, prior to back-fill.
6. Provide expansion devices as per Section 23 0516.
7. Provide shut off devices as noted in section 23 0523.
8. Refer to Section 23 2116 for hydronic specialties related to air vents and drain valves.
9. For new installation of underground piping utilities, provide by-pass loops at either end to allow for appropriate cleaning and flushing of new system. By-pass loops shall be designed to meet related flow / velocity requirements, as outlined in 23 2500.
10. Install above grade piping to be serviceable at points of isolation through and accessible ceiling system or other appropriate means.
11. Provide unions or flanges adjacent to valves, control instrumentation, regulators, and at final equipment connections for removal of all appurtenances that may require maintenance or replacement.
12. Provide appropriate means of access (including mechanical extensions, sleeves, and covers) for all underground piping appurtenances that will need to be exercised / actuated either by manual or automatic means.
13. Provide traffic rated removable covers/lids for all points and related appurtenances requiring access for underground utility systems. Covers shall require the following:
  - a) Maintain exterior collar so the removable portion does not come in contact with finished hardscape.

## USC DESIGN GUIDELINES

- b) Install flush with finish grade and subsequently identified (by means of welding) in accordance with FPM Facilities criteria for doing so on a per utility standpoint.
- 14. Carrier piping shall be hydrostatically pressure tested.
- 15. Steel outer conduit for steam pipe systems shall be tested by means of compressed air.
- 16. After hydrostatic testing, provisions shall be included to allow for the continued circulation of water in the piping system, until which point the system becomes fully operational.
- 17. Piping shall be flushed and cleaned per 23 2500 prior to connection with the rest of the campus loop. The piping shall not be connected to the campus loop until USC has approved the Cleaning and Passivation form.
- 18. Coordinate with controls contractor and install all controls instrumentation required so as to be accessible and provided with proper clearance to service and/or replace.
- 19. Refer to Section 23 0519 for gage and flow meter requirements.
- 20. Provide steam vaults at 300 foot (overall developed length) intervals. Final interpretation of when and whether required shall be done by FPM Facilities.
  - a) Provide dry well at bottom of vault for drainage.
  - b) Provide ladder with 20" width minimum.
  - c) Provide lid with 36" diameter minimum.
  - d) Provide high and low venting inside vault to terminate in exterior mushroom type cap Alhambra Foundry model A-2169 or equal. Cap to be painted to match surrounding exterior.
- 21. Refer to the following detail for piping at the building connection. Provide isolation valves and bypass when connecting building onto campus central hydronic piping systems in order to separate the building cleaning and flushing efforts from the site utility. Refer to Section 23 2113 for reference:

## USC DESIGN GUIDELINES



22. Insulation requirements:

- a) A continuous vapor barrier must be maintained and integrity intact for protection from external elements.
- b) Install rigid insertion rings between insulation and carrier pipe at all underground pipe supports to protect from compression of insulation material due to point loads.
- c) Install insulation on piping accessories requiring future re-occurring access and service with factory fabricated insulation covers that are easily removed and re-applied.
- d) Where insulation of pipe joints and fittings must be done in the field, contractor shall provide documented procedures for this activity, and coordinate with Inspector of Record, prior to back-fill. The Inspector of Record shall be present during the application of insulation at these fittings.

5. **EVALUATION or COMMISSIONING**

- A. List of items or systems requiring testing, evaluation, verification, or commissioning: Hydrostatic Pressure testing. See also Cleaning and Passivation requirements in 23 2500.
- B. Documentation required:
  1. Test reports: Hydrostatic Pressure Testing.
- C. Required testing protocols:
  1. Hydrostatic Testing Procedures (used for both Hydronic and steam piping):
    - a) Use ambient temperature water as a testing medium.
    - b) While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
    - c) Isolate expansion tanks and cooling towers, and determine that hydronic system is full of water.

## USC DESIGN GUIDELINES

- d) Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure, but meeting code requirements as noted below. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
- e) As indicated in 2010 California Mechanical Code Section 1201.2.8, piping shall be tested with a hydrostatic pressure of not less than 100 psig, but at least 50psig greater than operating pressure. Required tests shall be conducted by the contractor in the presence of an authorized inspector. The piping being tested shall remain exposed to the inspector and shall not leak during the test.
- f) After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
- g) Contractor to coordinate with Inspector of Record to prepare written report of testing for Owner's Representative, including description of repairs made. Include test bristol recording.
- h) Any deviations from the hydrostatic pressure testing protocols found in this section shall be submitted for review and approval by FPM Facilities and Inspector of Record.

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 33 7000 ELECTRICAL-TELECOM UTILITIES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Sections 26 00 00, 26 05 33, 26 05 53 and 33 00 00.
- C. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		

- D. This section relates to the following: Campus Site Utilities

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) FPM Facilities will identify connection location(s) and designated manhole(s) or handhole(s) for each project.
    - b) FPM Facilities will provide details and fault current information for each manhole or handhole.
  - 2. Preferred:
    - a) No preferences.
  - 3. Disallowed:
    - a) None.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS

- A. Underground Ducts:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: No preferences
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Concrete Encased Raceways:
        - i) PVC Schedule 40 Conduit for all encased underground raceways.



## USC DESIGN GUIDELINES

- 2) Exposed Conduit in Manholes:
    - i) Rigid steel conduit unless specified otherwise on Drawings
  - b) Preferred: No preferences
  - c) Disallowed: Direct buried raceways.
- B. Manholes and Handholes:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Jensen Precast
      - 2) Brooks Products, Inc.
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide manholes and handholes precast with 28-day, 3000 psi minimum compressive strength concrete and designed for AASHTO H-20 loading. Minimum dimensions for manholes and handholes are shown on the Drawings. Increase these dimensions as required by use of extension sections to accommodate the several raceway entrances at their required elevations.
      - 2) Slope floors toward drain points, leaving no pockets or other nondraining areas. Provide drainage outlet or pump sump at the low point of the floor constructed with a heavy, cast iron, slotted or perforated cover and 4-inch minimum outlet and outlet pipe.
      - 3) Provide a pulling iron embedded in the concrete wall opposite each raceway entrance and one in the floor vertically below the center of the manhole or handhole cover. Utilize 3/4-inch round stock securely fastened to the overall steel reinforcement before concrete is poured.
      - 4) Provide raceway entrances [as shown on the drawings] [on all four sides]. For raceways installed under this Contract, knockout panels or precast individual raceway openings may be used. On sides where no raceways are installed under this Contract, provide 12-inch high by 24-inch wide (minimum) knockout panels for future raceway installation.
      - 5) Utilize heavy-duty type frames and covers made of cast iron, suitable for H-20 loading, and having machined bearing surfaces. Provide indented type covers, solid top design, with two drop handles each. On the upper side of each cover, cast or burned by welder, in integral letters no less than 2 inches high appropriate titles, ELECTRIC HIGH VOLTAGE (for above 600 volts), ELECTRIC LOW VOLTAGE (for 600 volts and below), or TELEPHONE. Field stamp covers with manhole or handhole numbers indicated on the Drawings.
      - 6) Provide heavy-weight cable racks with adjustable arms and acceptable insulators for all cables in each manhole. Set adjustable inserts in the concrete walls for the attachment of racks. Do not use bolts or studs embedded in concrete for attaching racks. Set racks and inserts on not greater than 3-foot centers around the entire inside perimeter of the manhole, arranged so that all spare conduit ends are clear for future cable installation. Provide racks with a sufficient number of arms and insulators to accommodate cables for each conduit entering or leaving the manhole, including spares.

## USC DESIGN GUIDELINES

- 7) Utilize manhole and handhole hardware of steel, hot-dip galvanized after fabrication.
  - b) Preferred: No preferences
  - c) Disallowed: None
- C. Raceway Tags:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: No preferences
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide permanent, stainless steel markers with raceway designations pressure embossed, or engraved onto the tag. Tags relying on adhesives or taped-on markers are not acceptable. Attach tags to raceways with noncorrosive stainless steel wire.
    - b) Preferred: No preferences
    - c) Disallowed: None
- D. Warning Tape:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) ITT Blackburn, detectable.
      - 2) Griffolyn Co. Terra-Tape, detectable
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide heavy-gauge, yellow or red or orange plastic tape of 6-inch minimum width for use in trenches containing electric circuits. Utilize tape made of material resistant to corrosive soil. Use tape with printed warning that an electric circuit is located below the tape.
    - b) Preferred: No preferences
    - c) Disallowed: None
- E. Moisture Sealing Material:
- 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: No preferences
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Where indicated or required, provide a two-part urethane foam sealant which when mixed will expand approximately 15 times in volume to form a dense, strong tough foam unit with a density of 3 to 4 pounds per cubic foot. Sealant shall reach 60% full strength in 8 to 10 minutes after application.
    - b) Preferred: No preferences
    - c) Disallowed: None

## USC DESIGN GUIDELINES

### 4. INSTALLATION REQUIREMENTS

#### A. Required:

##### 1. General

- a) Coordinate installation of underground raceways with other outside and building construction work. Maintain existing outside utilities in operation.
- b) Remove entirely and properly reinstall all raceway installations not in compliance with these requirements.
- c) Provide a minimum cover of 3 feet over the top of ductbank for underground raceways unless otherwise indicated.
- d) Do not backfill underground direct burial and concrete-encased raceways until they have been inspected by the Engineer, Owner or their representative.
- e) Core infrastructure shall be minimum 5" conduit, building laterals shall be sized according to the NEC, minimum size for high voltage shall be 3" conduit.
- f) Warning Tapes: Bury warning tapes approximately 18 inches above all underground conduit runs or duct banks. Align parallel to and within 12 inches of the centerline of runs.

##### 2. Separation and Support

- a) Separate parallel runs of two or more raceways in a single trench with preformed, nonmetallic spacers designed for the purpose. Install spacers at intervals not greater than that specified in the NEC for support of the type of raceways used, and in no case greater than 5 feet.
- b) Support raceways installed in fill areas to prevent accidental bending until backfilling is complete. Tie raceways to supports and raceways and supports to the ground, so that raceways will not be displaced when concrete encasement or earth backfill is placed.

##### 3. Arrangement and Routing

- a) Arrange multiple conduit runs substantially in accordance with any details shown on the Drawings. Locate underground conduits where indicated on the Drawings and graded to the elevations shown.
- b) Make minor changes in location or cross-section as necessary to avoid obstructions or conflicts. Where raceway runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, refer the condition to the Engineer for instructions before further work is done.
- c) Where other utility piping systems are encountered, maintain a 12-inch minimum vertical separation between raceways and other systems at crossings. Maintain a 12-inch minimum separation between raceways over couplings in other piping systems. Refer conflicts with these requirements to the Engineer for instructions before further work is done.
- d) In multiple conduit runs, stagger raceway coupling locations so that couplings in adjacent raceways are not in the same transverse line.

##### 4. Concrete Encasement

- a) Encase underground conduits in 3000 psi concrete, small aggregate. Maintain a minimum 3 inch envelope around all conduits. Refer to *Section 33 0000 Order of inverts* for backfill requirements.
- b) Maintain a grade of a least 4 inches per 100 feet, either from one manhole or pull box to the next, or from a high point between them, depending on the surface contour.

## USC DESIGN GUIDELINES

- c) Hold conduits for concrete-encased raceways securely in place by acceptable window type spacer supports. Where, in the opinion of the Engineer, ground conditions are such as to require concrete forms, install forms constructed of materials and in a manner acceptable to the Engineer. No variations greater than 1/2 inch in 50 feet will be permitted from a straight line.
  - d) Envelopes may be poured directly against the sides of trenches if the cut is clean, even, and free of loose material. Remove loose material from trenches before and during pouring of concrete to ensure sound envelopes. Carefully spade slurry during pouring to eliminate all voids under and between raceways and honeycombing of the exterior surface.
  - e) Do not use power-driven tampers or agitators unless they are specifically designed for the application, in order to ensure that the watertight integrity of the raceways is maintained.
  - f) Generally, place an entire concrete envelope in one continuous pour. Where more than one pour is necessary, terminate each pour in a sloped plane, and insert 3/4-inch reinforcing rod dowels extending into the slurry 18 inches minimum on each side of the joint. Obtain Engineer's approval for the number and location of dowels.
5. Manholes and Handholes
- a) Install manholes and handholes where shown on the drawings. Provide excavation, shoring, bracing, backfilling, grading, etc., in accordance with requirements specified elsewhere in these contract documents.
  - b) Do not install manholes or handholes until final conduit grading, including field changes necessitated by underground interferences, has been determined. Set frames to final grades as required.
  - c) Make installation so that raceways enter manholes or handholes at nearly right angles and as near as possible to one end of a wall, unless otherwise indicated.
  - d) Install two ground rods in opposite corners of each manhole and handhole. Connect all noncurrent-carrying metal parts in the manhole and any metallic raceway grounding bushings to this ground rod with No. 4/0 bare copper ground conductor and approved ground clamp and as required per NEC.
6. Preparation for Pulling in Conductors
- a) Do not install crushed or deformed raceways. Avoid traps in raceways where possible. Take care to prevent the lodging of concrete, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs and clean raceway interior before introducing conductors or pull wires.
  - b) Immediately after installation, plug or cap all raceway ends with water-tight and dust-tight seals until the time for pulling in conductors.
  - c) For concrete-encased raceways, after the concrete envelope has set, pull a mandrel of a diameter approximately 1/4 inch less than the raceway inside diameter, through each raceway. Then pull a bristle brush through each raceway to remove debris.

## USC DESIGN GUIDELINES

7. Empty Raceways
    - a) Certain raceways will have no conductors pulled in as part of the Contract. Identify with tags at each end and at any intermediate pull point the origin and destination of each such empty raceway. Where a raceway has been identified with a name (number) in the Raceway Schedule, use that name on the tag in lieu of origin and destination. Provide a removable permanent cap over each end of each empty raceway. Provide a 3/8" nylon pull cord in each empty raceway.
  8. As Built Conduit Drawings
    - a) At the completion of Contract, provide as-built conduit Drawings showing location and depth of all conduits. Measure conduit locations from permanently fixed readily discernable landmarks such as building corners, columns, manhole centerline, etc.
- B. Preferred: No preferences
- C. Disallowed: None.

### 5. EVALUATION or COMMISSIONING

- A. N/A

**END OF DOCUMENT**

# USC DESIGN GUIDELINES

## 33 71 19 ELECTRICAL UNDERGROUND DUCTS AND MANHOLES

### 1. OVERVIEW

- A. Purpose: USC preferences and requirements are indicated in this document.
- B. For other related requirements, refer to Section 26 00 00, 26 05 33 26 05 53 and 33 00 00.
- C. For telecommunication requirements, refer to Section 33 81 26
- D. The following table summarizes the types of particular requirements identified within this section:

Requirements listed	Preferences Listed	Disallowed items listed	Item requiring commissioning/testing
X	X		

- E. This section relates to the following: Electrical manholes and handholes

### 2. PROCEDURAL REQUIREMENTS

- A. Design considerations specific to components in this section:
  - 1. Required:
    - a) FPM Facilities will identify connection location(s) and designated manhole(s) or handhole(s) for each project.
    - b) FPM Facilities will provide details and fault current information for each manhole and/or handhole.
  - 2. Preferred:
    - a) No preferences.
  - 3. Disallowed:
    - a) None.
- B. Quality Assurance requirements beyond standard 1 year warranty: None required.

### 3. PRODUCT REQUIREMENTS

- A. Underground Ducts:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: No preferences
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Concrete Encased Raceways:

## USC DESIGN GUIDELINES

- i) PVC Schedule 40 Conduit for all encased underground raceways.
      - ii) Red colored concrete encasement. Red iron oxide pigment shall be integrally mixed into the concrete. Alternate for red oxide powder on top of the concrete encasement may be considered.
    - 2) Exposed Conduit in Manholes:
      - i) Rigid steel conduit
    - b) Preferred: No preferences
    - c) Disallowed: Direct buried raceways.
- B. Manholes and Handholes:
  - 1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) Jensen Precast
      - 2) Brooks Products, Inc.
    - c) Disallowed: None
  - 2. Component Characteristics:
    - a) Required:
      - 1) Provide manholes and handholes precast with 28-day, 3000 psi minimum compressive strength concrete and designed for AASHTO H-20 loading.
      - 2) Minimum requirements for manholes:
        - i) Dimensions: 8'-0" L x 10'-0" W x 7'-0" H
        - ii) Neck length – maximum 21"
        - iii) Ladder – minimum width of 20" where possible
        - iv) Lid – minimum diameter of 36"
      - 3) Minimum requirements for handholes:
        - i) Dimensions: 4'-0"L x 4'-0" W x 4'-0" H
        - ii) Handhole will be sized based on:
          - a) Number and size of cables installed
          - b) Quantity of splices
          - c) Straight through pull or 90 deg bend
      - 4) Exposed Conduit in Manholes: Rigid steel conduit
      - 5) Slope floors toward drain points, leaving no pockets or other non-draining areas. Provide drainage outlet or pump sump at the low point of the floor constructed with a heavy, cast iron, slotted or perforated cover and 4-inch minimum outlet and outlet pipe.
      - 6) Provide a pulling iron embedded in the concrete wall opposite each raceway entrance and one in the floor vertically below the center of the manhole or handhole cover. Utilize 3/4-inch round stock securely fastened to the overall steel reinforcement before concrete is poured.
      - 7) Provide raceway entrances as required by the scope of work. On sides where raceway openings will be as part of project, knockout panels or precast individual raceway openings shall be used. On sides where no raceways will be installed, provide 12-inch high by 24-inch wide (minimum) knockout panels for future raceway installation.
      - 8) Utilize heavy-duty type frames and covers made of cast iron, suitable for H-20 loading, and having machined bearing surfaces. Provide indented type covers, solid top design, with two drop handles each.

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On the upper side of each cover, cast or burned by welder, in integral letters no less than 2 inches high labeling on two lines. First line shall say "ELECTRICAL". Second line shall say "MH X" where X is the manhole number. Confirm manhole number with FPM Engineering prior to engraving.

- 9) Utilize manhole and handhole hardware of steel, hot-dip galvanized after fabrication.
    - b) Preferred: No preferences
    - c) Disallowed: None
- C. Cable Racks
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred: No preferences
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Provide heavy-weight cable racks with adjustable arms and acceptable insulators (insulated metal or plastic) for all cables in each manhole.
      - 2) Set adjustable inserts in the concrete walls for the attachment of racks. Do not use bolts or studs embedded in concrete for attaching racks.
      - 3) Set racks and inserts on not greater than 3-foot centers around the entire inside perimeter of the manhole, arranged so that all spare conduit ends are clear for future cable installation.
      - 4) Provide racks with a sufficient number of arms and insulators to accommodate cables for each conduit entering or leaving the manhole, including spares.
      - 5) Racks shall be installed at least 8" down from the top of the manhole and at least 8" up from the bottom of the manhole.
- D. Warning Tape:
1. Manufacturers:
    - a) Required: No requirements
    - b) Preferred:
      - 1) ITT Blackburn, detectable.
      - 2) Griffolyn Co. Terra-Tape, detectable
    - c) Disallowed: None
  2. Component Characteristics:
    - a) Required:
      - 1) Provide heavy-gauge, yellow or red or orange plastic tape of 6-inch minimum width for use in trenches containing electric circuits. Utilize tape made of material resistant to corrosive soil. Use tape with printed warning that an electric circuit is located below the tape.
    - b) Preferred: No preferences
    - c) Disallowed: None
- E. Moisture Sealing Material:
1. Manufacturers:
    - a) Required: No requirements



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- b) Preferred: No preferences
  - c) Disallowed: None
2. Component Characteristics:
- a) Required:
    - 1) Where indicated or required, provide a two-part urethane foam sealant which when mixed will expand approximately 15 times in volume to form a dense, strong tough foam unit with a density of 3 to 4 pounds per cubic foot. Sealant shall reach 60% full strength in 8 to 10 minutes after application.
  - b) Preferred: No preferences
  - c) Disallowed: None

### 4. INSTALLATION REQUIREMENTS

- A. Required:
- 1. General
    - a) Coordinate installation of underground raceways with other outside and building construction work. Maintain existing outside utilities in operation.
    - b) Remove entirely and properly reinstall all raceway installations not in compliance with these requirements.
    - c) Minimum coverage over top of underground raceways shall be 36" to top of conduit, concrete encasement, and slurry backfill for all voltages over 120V.
    - d) Backfill underground direct burial and concrete-encased raceways only after they have been inspected by the Engineer, Owner or their representative.
    - e) Core infrastructure shall be minimum 5" conduit, building laterals shall be sized according to the NEC, minimum size for high voltage shall be 5" conduit.
    - f) Warning Tapes: Bury warning tapes approximately 18 inches above all underground conduit runs or duct banks. Align parallel to and within 12 inches of the centerline of runs.
  - 2. Separation and Support
    - a) Separate parallel runs of two or more raceways in a single trench with preformed, nonmetallic spacers designed for the purpose. Install spacers at intervals not greater than that specified in the NEC for support of the type of raceways used, and in no case greater than 5 feet.
    - b) Support raceways installed in fill areas to prevent accidental bending until backfilling is complete. Tie raceways to supports and raceways and supports to the ground, so that raceways will not be displaced when concrete encasement or earth backfill is placed.
  - 3. Arrangement and Routing
    - a) Arrange multiple conduit runs substantially in accordance with any details shown on the Drawings. Locate underground conduits where indicated on the Drawings and graded to the elevations shown.
    - b) Make minor changes in location or cross-section as necessary to avoid obstructions or conflicts. Where raceway runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, refer the condition to the FPM Facilities for instructions before further work is done.

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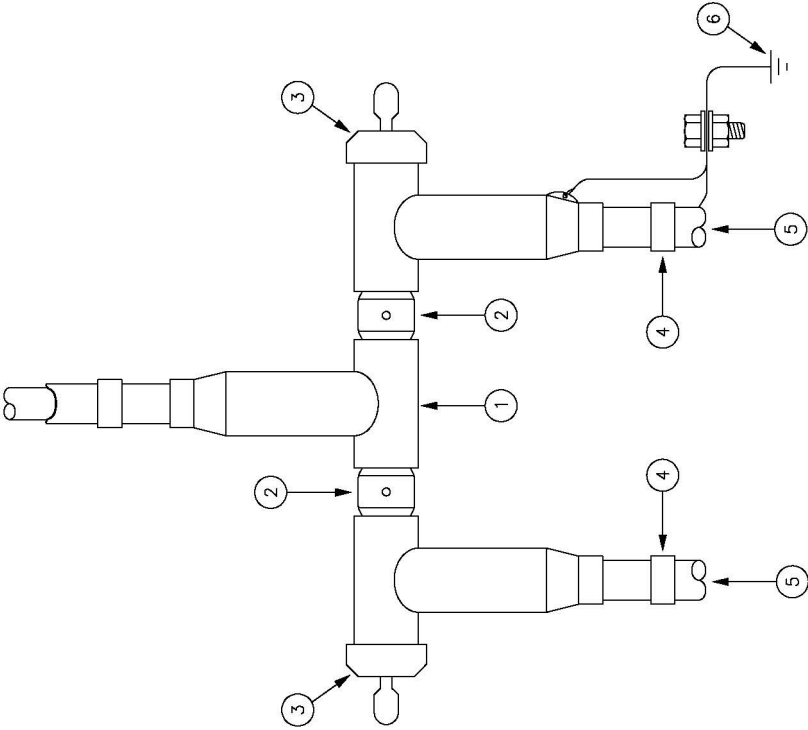
- c) Where other utility piping systems are encountered, maintain a 12-inch minimum vertical separation between raceways and other systems at crossings. Maintain a 12-inch minimum separation between raceways over couplings in other piping systems. Refer conflicts with these requirements to FPM Facilities for instructions before further work is done.
  - d) In multiple conduit runs, stagger raceway coupling locations so that couplings in adjacent raceways are not in the same transverse line.
4. Concrete Encasement
- a) Encase underground conduits in 3000 psi concrete, small aggregate. Maintain a minimum 3 inch envelope around all conduits. For backfill requirements refer to *Section 33 0000 Order of Inverts*.
  - b) Maintain a grade of a least 4 inches per 100 feet, either from one manhole or pull box to the next, or from a high point between them, depending on the surface contour.
  - c) Hold conduits for concrete-encased raceways securely in place by acceptable window type spacer supports. Where ground conditions are such as to require concrete forms, install forms constructed of materials and in a manner acceptable to FPM Facilities. No variations greater than 1/2 inch in 50 feet will be permitted from a straight line.
  - d) Envelopes may be poured directly against the sides of trenches if the cut is clean, even, and free of loose material. Remove loose material from trenches before and during pouring of concrete to ensure sound envelopes. Carefully spade slurry during pouring to eliminate all voids under and between raceways and honeycombing of the exterior surface.
  - e) In order to ensure that the watertight integrity of the raceways is maintained, only use power-driven tampers or agitators specifically designed for the application.
  - f) Place an entire concrete envelope in one continuous pour. Where more than one pour is necessary, terminate each pour in a sloped plane, and insert 3/4-inch reinforcing rod dowels extending into the slurry 18 inches minimum on each side of the joint. Obtain Engineer's approval for the number and location of dowels.
5. Manholes and Handholes
- a) Install manholes and handholes where shown on the drawings. Provide excavation, shoring, bracing, backfilling, grading, etc., in accordance with USC requirements.
  - b) Install manholes or handholes after final conduit grading, including field changes necessitated by underground interferences, has been determined. Set frames to final grades as required.
  - c) Make installation so that raceways enter manholes or handholes at nearly right angles and as near as possible to one end of a wall, unless otherwise indicated.
  - d) Install two ground rods in opposite corners of each manhole and handhole. Connect all noncurrent-carrying metal parts, including the ladder, in the manhole and any metallic raceway grounding bushings to this ground rod with No. 4/0 bare copper ground conductor and approved ground clamp and as required per NEC.
6. Preparation for Pulling in Conductors
- a) Do not install crushed or deformed raceways. Avoid traps in raceways where possible. Take care to prevent the lodging of concrete, dirt, or trash in raceways, boxes, fittings and equipment during the course of

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- construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs and clean raceway interior before introducing conductors or pull wires.
- b) Immediately after installation, plug or cap all raceway ends with water-tight and dust-tight seals until the time for pulling in conductors.
  - c) For concrete-encased raceways, after the concrete envelope has set, pull a mandrel of a diameter approximately 1/4 inch less than the raceway inside diameter, through each raceway. Then pull a bristle brush through each raceway to remove debris.
7. Empty Raceways
- a) Certain raceways will have no conductors pulled into. Identify with labels at each end and at any intermediate pull point the origin and destination of each such empty raceway. Where a raceway has been identified with a name (number) in the Raceway Schedule, use that name on the tag in lieu of origin and destination. Provide a removable permanent cap over each end of each empty raceway. Provide a 3/8" nylon pull cord in each empty raceway.
8. Manhole Direction Labeling
- a) Label each wall in the manhole with white spray paint the corresponding direction when facing that wall. N= North, S= South, W= West, E= East.
9. As Built Conduit Drawings
- a) At the completion of Contract, provide as-built conduit Drawings showing location and depth of all conduits. Measure conduit locations from permanently fixed readily discernable landmarks such as building corners, columns, manhole centerline, etc.
10. As Built Photos
- a) At the completion of Contract, provide as-built photos showing each wall of the manhole including a description of the direction.
- B. Preferred: No preferences
- C. Disallowed: None.

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## 5. EXHIBITS

<p><b>NOTES:</b></p> <ul style="list-style-type: none"> <li>① 600A SEPARABLE INSULATED DEAD-BREAK CONNECTOR.</li> <li>② CONNECTING PLUG.</li> <li>③ DEAD-END PLUG AND VOLTAGE DETECTION CAP.</li> <li>④ CABLE GROUNDING ADAPTOR KIT.</li> <li>⑤ 15KV CABLE.</li> <li>⑥ CONNECTION TO MANHOLE GROUND ROD.</li> </ul>	<p><b>ACCEPTED MANUFACTURERS:</b></p> <p>1. OKONITE</p>	<p><b>USC</b> UNIVERSITY OF SOUTHERN CALIFORNIA <i>Facilities Management Services</i></p> <p>943 West 25th Street, TRLD06 Los Angeles, CA 90089-0821 (323) 742-5877</p>
		<p>SCALE: NONE</p>
<p>MEDIUM VOLTAGE CONNECTION</p>		

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## EVALUATION or COMMISSIONING

A. N/A

END OF DOCUMENT