Building Information Modeling (BIM) Guidelines

version 1.6

For Design Bid Build Contracts

USC Capital Construction Development and Facilities Management Services

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1. Introduction

This document defines the Design and Construction scope of work and deliverables for using Building Information Modeling (BIM) on new USC construction projects, major renovations and other projects as required by USC, based on a Design Bid Build form of Contract.

1.1 STATEMENT OF PURPOSE

If used effectively, BIM provides opportunities to vastly improve upon traditional methods of design and construction coordination thereby reducing the potential for costly change orders, providing multiple opportunities for Owner review and participation by means of 3D visualization of the project and specialty spaces, and reducing design and construction schedules. In addition, BIM creates opportunities for reusing data for multiple purposes, including the operation and maintenance of USC’s facilities. To achieve these ends, the BIM must be structured to achieve the required purposes. This document describes USC’s requirements for the production and use of Building Information Models (BIM) in the design, construction and maintenance of its facilities.

1.2 BUILDING INFORMATION MODEL

“Building Information Model” (BIM) is a parametric, computable representation of the project design developed by the Designer and their consultants, the Contractor, and their subcontractors, including construction details developed by the Contractor and its respective consultants and subcontractors that are integrated into the model. As used in this BIM Specification, references to Building Information Model, BIM, or the Model, include the primary design model or models and all linked, related, affiliated or subsidiary models developed for design, analysis, estimating, detailing, fabrication, construction, operation or maintenance of the project, or any portion or element of the project, whether the model is prepared by the Designers, the Contractor or prepared by the Contractor’s subcontractors or consultants.

1.3 KEY INGREDIENTS FOR SUCCESS

There are several factors that will affect the successful outcome of a BIM-based project:

a. Establishing a collaborative environment and a collaborative use of the BIMs during the design and construction process where the Designers, Contractor, subcontractors and Owner work together with a proactive approach to issue resolution. Under the most collaborative of environments, the number of RFI’s generated can be significantly reduced as the team resolves many issues in face-to-face or web-based meetings.

b. Leveraging the BIMs to the fullest extent possible to shorten the construction schedule and reduce construction costs. This would include reviewing the BIMs with users and Facilities Management Services (FMS) personnel to ensure that all key personnel understand what the final product will look like and that accesses and clearances meet their expectations. The fewer surprises, the less likely there will be change orders down the line.

c. Ensuring that the “I” in BIM is fully represented in the data provided by the Building Information Models and that the data delivered is COBie compliant.
2. USC Responsibilities

Throughout the processes defined below, various USC departments will be reviewing the BIMs and verifying that the model content is accurate and up to date. These departments and their involvement as it pertains to the BIMs are as follows:

- **USC CAPITAL CONSTRUCTION AND DEVELOPMENT**

- **USC REAL ESTATE AND ASSET MANAGEMENT**

- **USC FACILITIES MANAGEMENT SERVICES (FMS):** Defines the FM model and data requirements (Appendix A and B). Reviews access and clearances to mechanical equipment and object naming conventions. In conjunction with the BIM Manager and/or BIM Facilitator, verifies that the systems and zones are defined appropriately.

- **THIRD PARTY COMMISSIONING AGENT:** To be identified in the bid documents.

- **USC CAPITAL CONSTRUCTION PROJECT MANAGER:**
  - Coordinates BIM reviews with various departments.
  - Inserts initial project information in BIM Execution Plan.
  - Insures that the BIM Project Execution Plan is adhered to for the duration of the project.
  - Facilitates access to e-Builder, USC’s PMIS and project collaboration server.

- **USC INFORMATION TECHNOLOGY SERVICES:** Defines IT data and model requirements.

- **USER GROUPS:** Review of BIM for layout, access, etc.

- **USC BIM CONSULTANT/FACILITATOR**
  - Provides model “mash-ups” for all MEPF trades in Navisworks (see illustration on page 20). The mash-ups are overlays of the final as-constructed fabrication models (provided by the subcontractors) with the 100% CD MEPF design models. This provides the Designers with a visual comparison of the two model types – design vs. fabrication - to assist them in making any required adjustments to their design model to match the “as constructed” condition.

  - In conjunction with USC FMS, will validate design models and subcontractor submittals for COBie compliance periodically and provide feedback for corrections.
3. Deliverables

3.1 BIM EXECUTION PLAN

As part of their respective proposals/bid submittals, the Architect and the General Contractor must submit a BIM Execution Plan (BEP) describing processes and procedures in place within their organizations used to coordinate and deliver the BIM’s and associated data according to the guidelines contained herein. See Appendix H for the BIM Execution Plan template to be used. USC will evaluate the BEP’s and provide feedback to the successful bidder at the time of contract award, after which the Contractor will have 2 weeks to make changes to the BEP and resubmit.

3.2 MODEL AND DATA DELIVERY

The final delivery of the BIM and associated data to USC will be in the form of:

a. Fully coordinated architectural, structural, civil and MEP 3D models in Revit at 100% CD by the Design Team.
b. All equipment schedules must be generated from the parameters embedded in the Revit model objects.
c. “As constructed” native format MEPF and structural models provided by the General Contractor.
d. Complete “as constructed” Revit models provided by the Designers conforming to USC FMS requirements as detailed in Appendix B.*
e. The following COBie 2.4 standard worksheets*, submitted by the General Contractor, with particular emphasis on the MEPF systems, shall be provided (at minimum) to meet the long term Facilities Management Goals:

- Contact (all fields)
- Facility (all fields)
- Floor (all fields)
- Space (all fields)
- Zone (all fields)
- Type (all fields)
- Component (all fields)
- System (all fields)
- Spare (all fields)
- Resource (all fields)
- Job (all fields)
- Document – for those documents that are assignable to an associated BIM element or system (all fields, installed equipment documentation, Approval By=“Contractor Certified”, Stage=“As-Built”) All documents will be placed in the assigned location on e-Builder.
  - Attribute (all fields, manufacturer-provided attributes, Category=“As-Built”)

*The COBie spreadsheet and information on how to use COBie may be found at [http://www.wbdg.org/resources/cobie.php](http://www.wbdg.org/resources/cobie.php).

Additional resources can be found in the sub-folder named “BIM Guidelines Reference Docs” in the “General Documentation” folder in e-Builder. e-Builder is USC’s Project Management Information System. Access to e-Builder will be granted through USC’s Project Manager.

d. A narrative describing the software used to create the BIMs including the software publisher, software name and version number.
DATA ACQUISITION, UPDATE AND DELIVERY PROCESS

E: EcoDomus can be used for this task
4. Design Team: BIM Process and Modeling Requirements

4.1 BIM AUTHORING SOFTWARE
The Architects and MEPF Designers must model their systems in Revit. The Civil Engineer and the Structural Engineer may opt to use alternative software such as Civil 3D and Tekla.

The version number of any software to be used including collaboration software (e.g. Revit, Tekla, Navisworks, etc.) must be announced at the start of the project and must be maintained throughout project close-out unless the team as a whole agrees to upgrade to a newer version.

4.2 GEO-REFERENCED MODEL
The Architects will set the spatial coordinates at the beginning of the project. The coordinates will be accurately geo-referenced to a permanent campus monument. This will be coordinated between the Civil Engineer, the Architects and USC. It is the Architects responsibility to verify the accuracy of the coordinates and to provide a grid intersection at 0,0 for all other team members.

4.3 PROJECT COLLABORATION SERVER
The Design and Construction team is required to use USC’s PMIS server, e-BUILDER for all project related documentation, including all BIMs. Each project contains a BIM folder (see illustration below). The BIM folder is strictly dedicated to 3D coordination models and files (such as REvit, Naviworks NWD’s, NWC’s, DWGs, etc.). Access to e-BUILDER will be provided by USC. Models will be accessible to all parties in both their native formats and in dwg and/or NWD/NWC/IFC formats (as requested). They will be posted to e-BUILDER on a regular basis as they get updated and/or modified.

4.4 DESIGN BIM FACILITATOR
The Design Consultant must have a dedicated full time BIM Facilitator/BIM Engineer. Design BIM Facilitator responsibilities include:

a. Ensuring that all members of their Design Team are delivering and updating the BIM’s according to schedule.
b. Ensuring that the BIM’s get uploaded to the common server on time and in the correct file format(s).

c. Ensuring that the submitted BIM’s comply with all of the requirements as defined in this document including COBie data requirements.

d. Assembling the submitted BIM’s into a single consolidated BIM in Navisworks and reviewing the consolidated BIM for coordination and constructability issues.

e. Providing design coordination and constructability feedback.

f. Facilitating design coordination meetings and e-mailing webcast invitations to the meetings at least 1 day prior to meeting.*

g. Having a solid working knowledge of Navisworks, Revit, and any other software tools to be used for BIM and model checking.

h. Ensuring that BIM’s are used appropriately to test design requirements/ criteria.

i. Serves as POC for all internal and external BIM’s with USC and the General Contractor.

j. Ensuring that the model is geospatially located. (see item #6.)

k. Ensuring that the common reference point is distributed and used by ALL team members.

l. Having a pro-active approach to problem solving and ensuring that everyone has what they need when they need it.

*Equipment and webcasting software used for the coordination meetings should be checked at least 15 minutes prior to the meeting.

4.5 MODEL QUALITY AND LEVEL OF DETAIL: ARCHITECTURAL AND MEPF

a. The Designers will set up the required parameters and fields in Revit to meet the FMS requirements.

b. The Architects and MEPF Designers will review the Revit warnings periodically throughout the entire design process and correct any significant modeling issues. See Appendix E for a list of Revit model requirements and Revit warnings to correct.

c. All interior walls must be modeled to their correct heights and the corresponding Revit families must represent the entire wall assemble accurately.

d. Acoustic tile and hard lid ceilings may be represented as a plane with a thickness representing the total construction thickness.

4.6 AUDIO VISUAL AND OTHER SPECIALTY DESIGN DISCIPLINES

The AV system and any other specialty disciplines will be provided in a separate Revit file. All of the same rules apply as for the main design disciplines.

4.7 COBie

a. The Design Team shall submit the design data to USC as a COBie-compliant Excel file. The COBie-compliant file should be in the current version at the time of the submission (version 2.4 is the current version as of January 2011). EcoDomus may be used to automate the extraction of the COBie data from the Revit models. See APPENDIX H for a description of the verification process using EcoDomus.

b. USC, in conjunction with the BIM Consultant, will check the quality of the data against the requirements provided by the Owner and detailed herein. If the requirements are not met, the Design Team shall resubmit the data within two weeks after USC provides a report of inaccurate or missing data. If the second submission does not satisfy USC’s requirements the Design Team shall resubmit the data within one week after USC provides a report on found errors.

c. The COBie Excel file should contain the fields ExtSystem, ExtObject, ExtIdentifier properly populated for all provided elements in order to establish a relationship between the authoring BIM/CAD or project management software and corresponding elements in the COBie file.
5. MEPF Specifications

5.1 SHARED PARAMETERS

The Designers must submit their Revit templates and shared parameters files with USC FMS for review and approval.

See Appendix B: MASTER ATTRIBUTES (page 28) for required parameter fields for ALL MEPF system families.

5.2 NOMENCLATURE

Naming conventions for equipment types should be succinct, useful and descriptive. The names provided should allow for easy identification and be easily understood in order to facilitate the operation, repair and maintenance of USC equipment.

Appendix C provides nomenclature guidance.

5.3 WORKSETS

The MEPF Designers will create separate worksets in Revit for each MEPF trade and corresponding 3D views for each trade. The 3D views will be stored in a separate folder in the project browser designated: “3D for COORDINATION”. It is the responsibility of the Designers’ BIM Facilitator to ensure the correct and necessary visibility of the items in the designated views. At a minimum, the following 3D MEPF views should be created without overlap of associated data:

- Plumbing
- HVAC Wet (i.e. HHW, CHW)
- HVAC Dry (i.e Ducts)
- Mechanical Equipment
- Electrical Power
- Lights (with light source disabled in the light families)*
- Fire Sprinkler
- Methane (if applicable)

*The purpose for disabling the revit family light sources is to remove the glow that appears in Navisworks as an object.

5.4 ISOLATABLE SYSTEMS AND ZONES

MEPF systems must be defined within Revit such that each system can be isolated and viewed separately.

AREAS – The Architectural model must contain areas, such as occupancy or departmental, as required by the program design.

ZONES – The Mechanical model must contain MEPF zones, such as air circulation zones or others as required by the program.
5.5 BUILDING LINE

The Design Team will create a building line in CAD (approx. 5’ from building) up to which all underground utilities should be extended. The defined building line is not arbitrary. The civil utilities will be taken precisely up to that line where they will meet the corresponding building utilities. There should be no overlapping of utilities around the defined building line.

6. Design Phases

6.1 DELIVERABLE SCHEDULE AND MILESTONES (to be completed by the end of each phase)

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<th>Milestone</th>
<th>Deliverable</th>
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<tbody>
<tr>
<td>Contract Award</td>
<td>Final BIM Execution Plan</td>
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<tr>
<td>Schematic Design Phase</td>
<td>Architectural Model</td>
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<td>Civil Model</td>
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<td>COBie Design Data</td>
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### 6.2 SCHEMATIC DESIGN PHASE

#### 6.2.1 GENERAL

The Design Team may use any method to begin the design process but shall be using a BIM authored model(s) by completion of this phase. All information needed to describe the schematic design shall be included in and derived from these models. Deliverables are required as stated in the Deliverable and Milestones schedule.

#### 6.2.2 MODEL CONTENT

**a. Civil Surface and Utilities**

Detailed requirements of what is to be included in surveying deliverables is managed by USC staff in consultation with the Design Team on a project by project basis. Surveys shall be provided in electronic format and minimally include 3D topographic information including paving and retaining walls and all civil utilities. See item #6 on Geo-referencing requirements.

The Civil Engineer will provide Control Points to be used by the Design Team as a reference for developing the project gridlines and location.

The Design Team shall model all existing conditions as needed and the level of information to be included will be determined based upon project needs. The BIM Execution Plan should define the agreed upon scope of the modeling effort.

**b. Architectural**

The model geometry shall include:

- The building footprint definition and all exterior walls.
- All interior wall definitions with all rooms modeled individually.
- All fenestration.
- All doors.
- All overhangs, sun shades and roof monitors.
- All floors, with a separate floor finish model element per room.

#### 6.2.3 LEVEL OF DETAIL (LOD)

All elements shall be modeled to AIA standard LOD 100 by the appropriate design disciplines. Clearances and access zones should be modeled on separate layers, one layer per system.

**LOD 100 Model Content Requirements:** Overall building massing indicative of area, height, volume, location and orientation.

#### 6.2.4 PROGRAM AND SPACE VALIDATION

The Design Team shall use the BIM Authoring software or other analysis tools to compare and validate the stated program requirements with the actual design solution.

The following shall be developed automatically from the Building Information Model:

- Assignable Areas and Non-assignable Areas measured to inside face of wall objects and designated boundaries of areas.
- Gross Area measured to the outside face of wall objects.
6.2.5 COBie DESIGN DATA

The Design Team shall submit the design data to USC in spreadsheet format in compliance with the most current version of COBie**. This data set shall include those COBie “designer” worksheets related to the architectural program. The following COBie Design worksheets shall be provided in the Schematic Design Set:

- **Contact** (all fields)
- **Facility** – Facility(ies) referenced in the file (all fields)
- **Floor** – Description of vertical levels (all fields)
- **Space** – Spaces referenced in the project (all fields)
- **Zone** (all fields)

**Alternatively, EcoDomus software can be used to automate the extraction of the data from the BIM. At later design and construction phases EcoDomus can also be used to link related documents to the BIM objects, for field data entry, and for data quality control.

6.2.6 INITIAL COLLISION REPORT AND CONSTRUCTABILITY

The Design Team BIM Facilitator is to assemble all of the models into a single consolidated model and may use automated collision detection software for this phase of the work in addition to performing a visual walk through of the model from various perspectives and cross sections to detect any constructability issues that would not necessarily be detected automatically. If practical, review the consolidated model and corresponding clashes on a floor by floor basis.

All disciplines should be clashed against one another and all clearances and access zones should be verified either by clash detection or visual inspection to be clear of any unacceptable obstructions. The intention is to have as error and collision free a model as possible at each submission phase.

See Appendix F for suggested methodology for tracking collision and design issues.

6.3 DESIGN DEVELOPMENT PHASE

6.3.1 GENERAL

The Design Team shall continue developing their BIMs. Parametric links shall be maintained within the models to enable automatic generation of all plans, sections, elevations, custom details and schedules as well as 3D views. Deliverables are required as stated in the Deliverable and Milestones schedule (see item 6.1).

6.3.2 MODEL CONTENT

See Appendix A for the list of minimum required model elements.
6.3.3 LEVEL OF DETAIL (LOD)

All elements shall be modeled to AIA standard minimum LOD 200 by the appropriate design disciplines. Clearances and access zones should be modeled on separate layers, one layer per system.

**LOD 200 Model Content Requirements:** Model Elements are modeled as generalized systems or assemblies with approximate quantities, size, shape, location and orientation.

6.3.4 COBie DESIGN DATA

The Design Team shall submit the design data in conformance with the most current version of COBie. This data set shall include those COBie “designer” worksheets related to the architectural program. The Designer shall specifically identify spatial and systems zoning to reflect the space circulation zones and building service zones that are reflected in the design drawings and specifications. The following COBie Design worksheets shall be provided in the Schematic Design Set:

- **Contact** (all fields)
- **Facility** (all fields)
- **Floor** (all fields)
- **Space** (all fields)
- **Zone** (all fields)
- **Type** (Name, CreatedBy, CreatedOn, Category, Description, AssetType, ExtSystem, ExtObject, ExtIdentifier)
- **Component** (Name, CreatedBy, CreatedOn, TypeName, Space, Description, ExtSystem, ExtObject, ExtIdentifier)
- **System** (all fields)

6.3.5 COLLISION DETECTION AND CONSTRUCTABILITY

Repeat process described in Appendix F.

6.4 CONSTRUCTION DOCUMENTS PHASE

6.4.1 GENERAL

The Design Team shall continue development of the models created in the Design Development Phase. Parametric links shall be maintained within the models to enable automatic generation of all plans, sections, elevations, custom details and schedules as well as 3D views. Deliverables are required as stated in the Deliverable and Milestones schedule, item #6.1.

See Appendix A for the list of minimum required model elements.

6.4.2 MODEL CONTENT

Refinement of the model content defined in the design development phase. Whatever content was not known at that time should be accurately represented in this phase.

6.4.3 LEVEL OF DETAIL (LOD)

All elements shall be modeled to AIA standard minimum LOD 300 by the appropriate design disciplines. Clearances and access zones should be modeled on separate layers, one layer per system.

**LOD 300 Model Content Requirements:** Model elements are modeled as specific assemblies accurate in terms of quantity, size, shape, location and orientation.
6.4.4 PROGRAM AND SPACE VALIDATION

The Design Team shall use the methodology described in item 6.2.4 to reconfirm the program.

6.4.5 OTHER ANALYSIS AND CHECKING TOOLS

The Design Team shall analyze the design using software that interacts with the model in order to refine load calculations, daylighting, natural ventilation, acoustics, code issues and design issues in addition to reviewing and correcting any relevant issues arising out of the Revit warnings in both Revit Architecture and Revit MEP.

6.4.6 COBie DESIGN DATA

The Design Team shall re-submit the design data that was developed in the Design Development phase but further refined at this phase, to USC in conformance with the most current version of COBie.

- Contact (all fields)
- Facility (all fields)
- Floor (all fields)
- Space (all fields)
- Zone (all fields)
- Type (Name, Created By, Created On, Category, Description, Asset Type, Ext System, ExtObject, ExtIdentifier)
- Component (Name, Space, Typename, CreatedBy, CreatedOn, Category, Description, ExtSystem, ExtObject, ExtIdentifier)
- System (all fields)
- Document (all fields, submittals and similar documents, ApprovalBy = “Information Only”, Stage = “Requirement”)*
- Attribute (all fields, design-intent attributes, Category = “Requirement”)

*For all required closeout documents, go to: http://www.usc.edu/fms/documents/design_guidelines/Closeout_StandardGuideline.pdf

6.4.7 COLLISION DETECTION AND CONSTRUCTABILITY

a. The Design Team must provide a clash free design model employing the methodology described in item 6.2.6.

b. If there are any outstanding unresolved issues, The Design Team must submit a list of these with an explanation of why they could not be resolved.

6.5 BIDDING PHASE

6.5.1 ARCHIVING OF DESIGN BIMS

At the completion of Construction Documents, the 100% CD design BIMs will be archived in e-Builder and designated “As Designed”.

6.5.2 BID DELIVERABLE

The 100% CD BIMs and associated documentation will be made available to prospective General Contractor’s and their subcontractors for bidding purposes. The Design Team BIM Facilitator will provide the General Contractor with access to the BIM files. It will be the responsibility of the General Contractor to distribute models as they deem necessary to bidding subcontractors. It should be noted however, that access to the BIMs is provided for reference, clarification and design intent only and if used for estimating or any other purpose, is done so at the sole risk of the General Contractor and its subcontractors.
6.5.3 BIM EXECUTION PLAN

The General Contractor shall submit a BIM Execution Plan describing processes and procedures in place within their organization to coordinate and deliver the BIM’s and associated data according to the guidelines contained herein. See Appendix I for the BEP template to be used.

6.5.4 CO-LOCATION

While co-location of the design and construction teams during construction is desirable and highly encouraged, USC recognizes that there are often space limitations which preclude this type of interactive engagement. It is imperative, however, that all project team members remain pro-actively engaged and responsive for the duration of the construction phase. Collaboration procedures shall be detailed in the BIM Execution Plan (Appendix H).

6.5.5 DESIGN MODEL UPDATES

a. The Design Team will continue to develop and update the design models throughout the entire construction process. For any design changes that have a direct and immediate effect on construction coordination, the Design Team must update and re-upload their design models to the project BIM folder in e-Builder within 3 work days if there is an ASI, MSI, SSI or any other question that is answered by the Design Team that requires a design change or a change order that affects coordination or that is driven by coordination (such as ceiling elevation changes or a change in the size of a shaft opening).

b. The MEP Engineers will not be uploading changes to the MEPF models but will be updating their MEPF design models immediately following the subcontractor sign off of a given floor on a floor by floor basis. Model mash-ups (see item 6.5.6 below) can be used as a check to ensure that the design model mimics the fabrication models.

c. All stakeholders can subscribe to automatic notification when new models are uploaded to e-Builder. Select the folder in your project to which you wish to subscribe (i.e. BIM) and click on “subscribe” in the menu bar.

e-Builder folder subscription

d. The Architects will publish a monthly bulletin summarizing all questions, resolutions and model changes/updates, and all decisions for design or for value engineering that have been made and will post the bulletins to the server as a non-editable file along with the updated models.

All of the above described bulletin items shall be recorded in the model with labeled bubbles around the affected area with reference to the bulletin item number.

e. The Structural Designer will be updating the design model in parallel with the steel fabricator. In some cases, the Designer’s structural model may be the only model used throughout.
6.5.6 MODEL MASH-UPS

USC will provide model mash-ups for all MEPF trades in Navisworks. The mash-ups are overlays of the final as constructed fabrication models with the most up-to-date MEPF design models. This provides the Designers with a visual comparison of the two model types – design vs. fabrication - to assist them in making any required adjustments to their design model to match the “as constructed” condition. Model mash-ups will be created as each floor’s coordination is complete and is signed off by all of the trade subcontractors.

Sample mash-up of ductwork. Green duct must be adjusted to match as-built blue duct.

7. Construction Team: BIM Process and Modeling Requirements

7.1 BIM EXECUTION PLAN FEEDBACK AND REVISIONS

USC will provide a marked up version of the General Contractor’s BIM Execution plan with any comments or exceptions upon award of the contract. The General Contractor is required to make the appropriate revisions and re-submit for final approval one week after receipt of the marked up plan.

7.2 CONSTRUCTION BIM FACILITATOR

The General Contractor must have a dedicated full time BIM Facilitator/BIM Engineer on staff with proven at least 3 years of MEPF coordination experience and whose responsibilities include, but are not limited to:

a. Ensuring that all of the subcontractors are updating the BIMs according to schedule.
b. Ensuring that the BIM’s get uploaded to the common server on time and in the correct file format(s).
c. Ensuring that the submitted BIMs comply with all of the requirements as defined in this document including COBie data requirements.
d. Assembling the submitted BIMs into a single consolidated BIM in Navisworks and reviewing the consolidated BIM for coordination and constructability issues.
e. Providing construction coordination and constructability feedback.
f. Facilitating construction coordination meetings.
g. Having a solid working knowledge of Navisworks, Revit and any other software tools to be used for BIM and model checking.
h. Serving as the POC for all internal and external BIM’s with USC and the Designers.
i. Having pro-active approach to problem solving and ensuring that everyone has what they need when they need it.*
j. Creating a 3D Grid.
7.3 COBie CONSTRUCTION DATA

At the appropriate time, determined by the USC Project Manager, the General Contractor will be provided with an EcoDomus license and access to the EcoDomus project site which will contain partially populated COBie data derived from the design models. See Appendix H.

The General Contractor will be responsible for updating and adding additional data in EcoDomus as the data becomes available from the subcontractors, including:

- **Contact** (all fields)
- **Facility** (all fields)
- **Floor** (all fields)
- **Space** (all fields)
- **Zone** (all fields)
- **Type** (all fields)
- **Component** (all fields)
- **System** (all fields)
- **Spare** (all fields)
- **Resource** (all fields)
- **Job** (all fields)
- **Document** (all fields, installed equipment documentation, ApprovalBy = “Owner Approval”, Stage = “As-Built”)
- **Attribute** (all fields, manufacturer-provided attributes, Category = “As-Built”)

The Quality of the COBie data will be checked against the requirements provided by the Owner and detailed herein. If the requirements are not met, the General Contractor shall resubmit the data within two weeks after USC provides a report of inaccurate or missing data. If the second submission does not satisfy USC’s requirements, the General Contractor shall resubmit the data within one week after USC provides a report on found errors.

EcoDomus can be used for COBie compliance checking and data input. EcoDomus will be used by USC for linking all of the associated data in the 3D models to USC’s Facility Management and Maintenance systems and it is essential that the required fields and filename conventions be followed accurately.

The COBie compliant data will be verified and feedback provided by USC in conjunction with USC’s BIM Consultant at a minimum at the following construction stages:

- 75% Substantial Completion
- Commissioning Complete
- Project Close-Out

7.4 EXTRACTING INFORMATION FROM THE DESIGN MODEL

The General Contractor can extract any required 2D background, such as floor plans or reflected ceiling plans from the most current Revit files.

It is the General Contractor’s responsibility to export the individual trades and systems from Revit in an appropriate file format (.dwg OR .nwc, for example) for the corresponding subcontractors if necessary.

7.5 CONSTRUCTION MODEL UPDATES

All subcontractors shall update their models regularly during construction to reflect the accurate as constructed/as installed condition. This shall not be left until the end of the project. The General Contractor’s BIM Facilitator will be responsible for ensuring that this process is in place and for verifying compliance. Where installation differs from the coordinated model, a log of adjusted installations will be
kept detailing what the change was, the reason for the change and confirming that the 3D model has been updated accordingly. See Appendix D for sample log.

7.6 TRADE COORDINATION

7.6.1 Kick off Meeting

All members of the design and construction team are required to attend the initial BIM kick-off meeting in person at a designated USC location. There must be at least one representative from each trade. The General Contractor will provide the details of the meeting date, time and place.

7.6.2 Suggested Coordination Process

The process outlined below describes requirements and provides some guidance for a suggested coordination process. The General Contractor’s BIM Execution Plan will confirm the actual intended procedures to be implemented.

A BIM folder has been created in e-BUILDER (see illustration on p. 9) for uploading the 3D models produced by the Designers and subcontractors. These models will be accessible to authorized team members for individual coordination purposes on a trade by trade basis.

The General Contractor’s BIM Facilitator shall be responsible for integrating all of the 3D models into a single consolidated Navisworks NWF and NWD per floor, running clash detection and creating viewpoints of identified issues.

The MEPF detailers are required to submit models that are clash free from any structural components that are included in the structural model provided, to the best of their ability.

One integrated BIM per floor or zone shall be published in a Navisworks NWD file format and shall include numbered and labeled view sets of clashes and/or other design/constructability issues that the General Contractor uncovers during this process. The individual team members will be responsible for reviewing the saved views one by one prior to the next coordination meeting. To this end, all team members must have at their disposal one copy of Navisworks Manage.

Each party can be notified automatically when any file is uploaded if he/she so chooses.

For all e-mail communications on this project, preface the subject line with the acronym for this project: PROJECTNAMEACRONYM.

The General Contractor shall create a 3D grid for incorporation into the Navisworks file. A minimum of one copy of the 3D grid should be placed at each floor level and should be named according to the level that it is placed, e.g. 3D grid_L01. This will provide the viewer with a quick point of reference when navigating through the model.

All 3D detailers and associated foremen shall be required to attend regularly scheduled interactive coordination sessions facilitated by the General Contractor’s BIM Facilitator. Designers should be available upon request and should expect to attend a number of these sessions as well. During these sessions the coordination team shall review the consolidated model and the saved viewpoints on a floor by floor basis and find solutions to identified issues. Attendance via webcast is an option.

The BIM Facilitator shall include in the BIM Execution Plan a description of the methodology to be used for tracking and ensuring the timely resolution of clashes and/or constructability issues. A Clash matrix must be provided by the General Contractor’s BIM Facilitator with numbered viewpoints and with a description of the trades that are affected, matching the viewpoint numbers and labels in the associated Navisworks file. This matrix can be used by all parties to identify the agreed upon party(ies) responsible for resolving the clashes and to add personal notes. ALL matrix issues should be resolved by the designated trades responsible at least 24 hrs prior to the following coordination meeting.
The General Contractor must provide a BIM coordination room in a mutually agreed upon location for regularly scheduled 3D coordination meetings. The “BIM Room” must be equipped with the following minimum equipment and software specifications:

- 64 bit operating system on a desktop or laptop
- Navisworks Manage
- Document viewing software
- Projection system that allows for dual display

The General Contractor must be vigilant about engaging the design team on a regular basis to review, assess and provide feedback on any design related issues AS THEY ARISE.

Shear wall and slab penetration location information must be provided to the Structural Engineer as soon as a set location for said penetrations has been determined as a result of the 3D coordination effort. Initial locations of suggested penetrations can be provided by means of 3D viewpoints saved as jpegs, with dimensional information and grid references (if one or more of the 3D grid intersections can be seen in the view, that is sufficient) and/or in the form of 2D elevations with dimensions and grid references.

### 7.6.3 Installation

a. Field installation will use some form of optical survey or GPS instruments for hanger inserts at a minimum and for any other installation where practicable.

b. It is the General Contractor’s responsibility to ensure that all field personnel involved in the installation of MEPF at any level have at least minimal familiarity with the BIM models and understand by visual means what the repercussions are for changing the location of an installed item.

c. The General Contractor must have at least one dedicated workstation in the field (or within easy access) with the most current Navisworks files and documentation loaded (updated daily) for the duration of the construction process. This workstation shall be accessible by all field personnel. The Navisworks files shall have saved viewpoints for specific areas based on the planned and scheduled subdivision of work areas.

### 7.6.4 Requirements for 3D models, Formats and Model Structures

a. **FILE FORMAT:** All files should be exported to 3D DWG or Navisworks NWC or NWD format. Revit has a Navisworks plug-in for direct export to NWC. In addition, IFC files may be required and all subcontractors are required to have the capability of saving BIMs in the most current version of IFC.

b. **3D SOLIDS:** All objects must be modeled as 3D solids, not wire frame or lines.

c. **MODEL STRUCTURE:** Models should be created on a floor by floor basis from top of slab to top of slab. If this is impractical for certain trades, alternate solutions can be discussed.

d. **LEVEL OF DETAIL (LOD):** The models should contain the same level of detail as required for fabrication and installation. See Appendix A for required LOD.

e. **LIGHT SOURCES TURNED OFF:** Prior to exporting lights to Navisworks, make sure that the lights source is turned off in all of the light families. Otherwise the light source appears as a spherical object in Navisworks which is difficult to isolate globally.

f. **LOCAL COORDINATES:** When exporting Revit files to Navisworks, use local coordinates.

g. **CLEARANCES AND ACCESS:** All clearances and access to equipment, valves, etc. required by code or requested by USC for the purposes of operations and maintenance must be
modeled in 3D and kept in a separate layer and labeled correspondingly. These should be reviewed by the USC maintenance staff at approximately 80% coordination completion of each floor to verify the adequacy and practicality of the assigned space reservations and signed off at 95% to 100% coordination of each floor. This process shall be coordinated by USC’s Project Manager.

h. **TRADE COLORS:** Each trade shall be identifiable by a single color within Navisworks with the exception of architectural and structural elements as follows:

- HVAC Pipe: Lime Green
- Lights: Yellow
- Fire Sprinklers: Red
- Ceilings: Orange
- Steel: Maroon
- Methane: Forest Green

- Electrical: Cyan
- HVAC Duct: Blue
- Plumbing: Magenta
- Framing: Purple
- Concrete: Grey

![Navisworks Colors]

There is no need for individual trades to change their working color schemes; these will be altered when imported into Navisworks by the BIM Facilitator.

i. **COMMON REFERENCE POINT:** Once established, every trade must use the same agreed upon reference point or global coordinate system. The 2D reference grid, located accordingly, shall be provided by the Architects.

j. **“CLEAN” MODELS – NO X-REFS:** The 3D DWG and /or Navisworks models submitted should contain only relevant 3D data and no extraneous 2D data, nor should it contain any x-referenced files.

k. **FILE NAMING:** A file naming schema shall be provided by USC and this must be adhered to for all BIM uploads to the server. See BIM Execution Plan template, Appendix H.

l. **SOFTWARE:** The General Contractor must list the BIM software and versions they and their subcontractors will be using for this project.

**EXCEPTIONS:** List any exceptions to this document or alternate processes/methodologies that you would like to suggest subject to approval by USC and prior to submitting your BIM Execution Plan.
APPENDIX A: MODEL ELEMENTS AND LEVEL OF DETAIL FOR MODELS

DESIGN DEVELOPMENT AND CONSTRUCTION DOCUMENTS

1. Architectural

Model the architectural elements to a level that defines the design intent and accurately represents the design solution. The detail and responsibility to fulfill these modeling requirements should be addressed fully within the BIM Execution Plan.

- Architectural Site Plan (also see Civil Engineering section below). Paving, grades, sidewalks, curbs, gutters, site amenities and other elements typically included on enlarged scale site drawings in vicinity of building.
- Existing conditions to the extent required.
- New interior and exterior walls to their correct and accurate height including but not limited to: Doors, windows, openings
  All finishes need to be included within the wall type regardless of the thickness of the finish
  Interior and exterior soffits, overhangs, sun control elements
  Parapets, screening elements
  Architectural precast
- Floor, ceiling and roof systems including but not limited to:
  - Appropriate structural items listed below if not provided by the Structural Engineer and integrated into the architectural model for coordination and document generation. Insulation, ceiling systems, and floor are to be included.
  - Roof, floor and ceiling slopes, if needed, shall be modeled.
  - Soffits, openings, and accessories shall also be modeled.
  - Elevators, stairs, ramps including railing systems.
  - Casework, shelving, and other interior architectural elements.
  - Furnishings, fixtures, and equipment if not provided by others and integrated into the architectural model for coordination and document generation.
  - Furniture (Fixed and Loose).
  - Furniture Systems.
  - Specialty equipment (food service, medical, etc.).
  - Model mechanical, electrical and plumbing items that require architectural space (toilets/sinks/etc), require color/finish selection (louvers, diffusers, etc.) or affect 3D visualization (lighting fixtures) unless provided by Engineers.
  - Clearance zones for access, door swings, service space requirements, gauge reading, and other operational clearance must be modeled as part of all equipment and checked for conflicts with other elements. These clearance zones should be modeled as translucent solids on a separate layer.

2. Structural

Model the following structural elements. The detail and responsibility to fulfill these modeling requirements should be addressed fully within the BIM Execution Plan.

- Foundations such as:
  Spread Foundations
  Caisson Foundations
  Pile Foundations
  Mat Foundations
  Load-bearing Wall Foundations

- Framing such as:
  Steel Columns (with correct shape and size)
  Steel Floor C-joists
  Open Web Joists
  Joist Girders
  Steel Beams (with correct shape and size)
  Precast Concrete Elements (Hollow Core Plank may be modeled as a slab unless coordination with mechanical systems needs to occur because the hollow core is being used for those systems).
3. HVAC Systems

Model the following HVAC elements at a minimum. The detail and responsibility to fulfill these modeling requirements should be addressed fully within the BIM Execution Plan.

- **Equipment**
  - Fans, VAV’s, compressors, chillers, cooling towers, air handlers etc.

- **Distribution**
  - Supply, return, exhaust, relief and outside air ductwork modeled to outside face dimension or duct insulation (whichever is greater).
  - Duct Joints
  - Diffusers, grilles, louvers, hoods, radiant panels, perimeter units, wall units.

- **Pipes** sized at and over 3/4” diameter, include any insulation in model unless otherwise noted by the BIM Execution Plan.

- Clearance zones for access, door swings, service space requirements, gauge reading, and other operational clearance must be modeled as part of the HVAC equipment and checked for conflicts with other elements. These clearance zones should be modeled as invisible solids within the object.

4. Electrical systems

Model the following electrical elements at a minimum. The detail and responsibility to fulfill these modeling requirements should be addressed fully within the BIM Execution Plan.

- **Data, Power and Telecommunications**
  - Interior and exterior transformers, emergency generators, and other equipment.
  - Main and distribution panels and switchgear including access clearances.
  - Main IDF’s
  - Outlets, switches, junction boxes.

- **Lighting**
  - Permanently mounted lighting fixtures (moveable, plug-in fixtures need not be modeled as part of the electrical package unless needed for plug load calculations or for estimating purposes within a loose furnishings package. Should be discussed and agreed upon within the BIM Execution Plan).

- **Fire Alarm and Security Systems**
  - Input devices
  - Notification devices
5. Plumbing and Fire Protection

Model the following plumbing and fire protection elements at a minimum. The detail and responsibility to fulfill these modeling requirements should be addressed fully within the BIM Execution Plan.

- Waste and Vent
  Piping sized at and over 3/4” diameter, includes any insulation in the model unless otherwise noted by the BIM Execution Plan.
  Roof and floor drains, leaders, sumps, grease interceptors, tanks, water treatments and other major items.

- Supply
  Piping sized at and over 3/4” diameter, includes any insulation in the model unless otherwise noted by the BIM Execution Plan.
  Domestic Booster Pumps.

- Fixtures: sinks, toilet fixtures, water tanks, floor sinks

- Fire protection
  Sprinkler lines at and over 3/4” diameter.
  Sprinkler heads, Fire Protection Pumps.
  Stand pipes, wall hydrants, fire department connections, risers, including valve clearances.

- Clearance zones for access, service space requirements, gauge reading, valve clearances and other operational clearance must be modeled as part of the plumbing and fire protections system and checked for conflicts with other elements. These clearance zones should be modeled as invisible solids within the object.

6. Specialty Equipment

Suppliers should be requested to provide equipment models to an appropriate level of detail. If the latter are not obtainable, model the following specialty consultant elements to the correct size and in the correct location. Some of these items might occur in the above mentioned disciplines and should be discussed within the BIM Execution Plan.

- Equipment provided or specified by said consultant.
- Rough-in connection points for power, data, communications, water service and waste, gas, steam, or other needed utilities.
- Extent of specialty consultant modeling shall be coordinated with the Design Team and described in the BIM Execution Plan.
- Clearance zones for access, doors swings, service space requirements, controls, gauge reading, and other operational clearance must be modeled as part of the equipment and checked for conflicts with other elements.

7. Civil Engineering

Model the following civil engineering elements at a minimum:

- Topography – 3D terrain of all site work as designed, including retaining walls. This model should include the site and surrounding areas that contribute to the site’s drainage system or otherwise impact on the site. In most cases this shall require that adjacent roadways be modeled.
- Landscaping elements: planting areas, such as raised planting beds and berms, parking islands, pools/ponds/other water features, terraces and other items not included elsewhere in the model.
- Stormwater management structures pump stations, fueling systems, manholes and other major items that impact on the overall project understanding or which may become project design constraints. All items must be geo-referenced such that all elements can be viewed as an overlay in the building information model.
General Concepts

- Installation of all utilities, regardless of size or diameter, shall be modeled.
- Layers shall be labeled as per the architectural drawings to identify the utilities.
- Model Clearance Requirements – Model should include code and maintenance items, such as valve handle swings and pull chain drops. Constructability clearances for a specific utility line or equipment shall be modeled in 3D and contained on one dedicated layer.
- Insulation should be included on all piping, plumbing and ductwork where required.
- Pre-Fabrication – Any pre-fabricated item shall be included in the model to ensure proper space and connections.
- All modeled objects must be custom/specific objects from the manufacturer – Generic model pieces should not be used for the ‘signed off’ coordination models.
- MEPF systems should contain a minimum amount of associated data for ease of identification: hot water, cold water, waste, supply, return, overall duct and pipe sizes, elevation, etc.

The models shall include, but are not limited to:

1. Architectural Model
   - Wall thickness and height – Required for routing main utilities, locating VAV boxes, identifying priority wall framing, wall penetrations, fire stopping.
   - Hard ceilings and soffits – Required for identifying HVAC diffuser locations, electrical fixture locations, and routing of utilities with openings for diffusers and lights.
   - Exteriors walls / storefront – Required for identifying the location of rain water leaders.
   - Shafts, wall chases – Required for identifying the correct locations of plumbing vents, and HVAC shafts.
   - Architectural features requiring utilities – Required for utility routing.
   - Architectural features in mechanical spaces – Required for utility routing.

2. Structural Model
   - Beams and columns
   - Braces and gusset plates
   - Supplemental steel
   - Miscellaneous supports for equipment, toilet partitions, etc.
   - External wall framing connections

3. Drywall/Framing Model
   - Studs, bottom and top track
   - Kickers or other drywall supports
   - Roof framing

4. Concrete Model
   - Footings and foundations
   - Area of influence zones under foundations
   - Slabs and slab depressions

5. Mechanical Model
   - Medium pressure duct – Required for coordination and routing of other trades as well as pre-fabrication.
   - Low pressure duct – Required for coordination and routing of other trades as well as pre-fabrication.
   - Shaft locations – Required for coordination and routing of other trades and for locating smoke dampers, etc.
   - Flanges
   - VAV boxes – Required for pre-fabrication purposes, coordination with HVAC heating hot water piping, tagged with correct Equipment ID.
   - Fire smoke dampers – Required in coordination, tagged with correct Equipment ID.
   - Flex ducts – Required for showing how low pressure ducts connect to the diffusers.
   - Diffuser locations and sizes – Required for coordination of finish utilities with the other fixtures in a room (like electrical fixtures, etc.).
   - All duct and pipe insulation – Should be included where required so that the maximum sizes are represented in the model. – Required for coordination.
• **Hangers and seismic bracing** – Required for coordination and routing of other trades and for inserting the deck correctly before installation begins.

• **HVAC piping to VAV boxes** – Main lines are required for coordinating with other trades; also required if they will be pre-fabricated; connections to VAV boxes can be left for field routing.

• **HVAC piping to Equipment** – Main lines are required for coordinating with other trades; also required if they will be pre-fabricated; final connections to equipment need to be coordinated on model as well.

• **Underground utilities** - Required for underground MEP / FP coordination.

• **Mechanical room**

• **All equipment** – Required for coordinating with other trades, tagged with correct Equipment ID.

6. **Electrical Model**

• **Branch and feeder conduits** – Required for coordination with other trades and for pre-fabrication. Conduits 3/4” and greater need to be modeled. Flex and MC not required.

• **All underground conduits** – Required for underground MEP / FP coordination.

• **Junction boxes** – Required for coordination with other trades.

• **Lighting fixtures** – Required for coordination with other trades and finish utilities like ceiling grid, sprinkler heads, HVAC diffusers and specialty lighting. Tag with Circuit number.

• **All lighting supports for special lighting** – Required for routing and coordination of other trades.

• **Cable trays and other supports** – Required for coordination with other trades.

• **Hangers and seismic bracing** – Required for coordination with other trades and for inserting the deck.

• **Equipment Panels** – Required for coordinating with wall framing to determine backing, etc. Tag with Panel number.

• **Electrical rooms** – Required for coordination with wall framing and other trades.

• **Bundles of cable or wiring** – Useful for coordination and pre-fabrication.

• **Outlets and switch locations in rooms** – Useful for pre-fabrication and coordination. Tag with Circuit number.

• **Electrical power off buttons**

• **All equipment** – Required for coordinating with other trades.

7. **Plumbing Model**

• **Plumbing fixtures** – Required for coordination with other MEP trades.

• **Graded cast iron pipe lines** – Required for coordination with other trades and pre-fabrication.

• **Underground storm and sewer pipes** – Required for underground utilities coordination and for pre-fabrication.

• **Waste and vent lines** – Required for coordination with other trades and with architectural walls, shafts and for pre-fabrication.

• **Cold and hot water piping** – Required for coordination with other trades and for pre-fabrication. Identify valves and tag with appropriate valve number.

• **Hangers and seismic bracing details** – Required for coordination with other trades and for inserting before installation.

• **Specialty piping** – Required for coordination with other trades and for pre-fabrication.

• **All equipment** – Required for coordination.

• **Methane**

8. **Sprinkler Model**

• **Sprinkler mains and branches** – Required for coordination with other trades and for pre-fabrication.

• **Sprinkler head drops** – Required for coordination with finish utilities like electrical lighting, diffusers, etc.

• **Sprinkler pipes** – Required if hard pipe is used, useful if the newer type of flex pipe is used.

• **Hangers and seismic bracing** – Required for coordination with other trades and for inserting the deck correctly before installation begins.

• **Underground utilities** - Required for underground MEP / FP coordination.

• **All equipment** – Required for coordination.

9. **Process Piping Model**

• **Process piping** – All piping, valves, actuators, and fittings required for coordination with other trades.

• **Hangers and seismic bracing** – Required for coordination and routing of other trades and for inserting the deck correctly before installation begins.

• **Process equipment** – A model of each piece of equipment must be provided by the equipment manufacturer for coordination with other trades.
10. Controls Model
   • **Conduit and tubing** – All Instrument Air, power and control wiring conduit, conduit and distribution boxes serving control tubing are required for coordinating with other trades.
   • **Equipment panels** – Required with associated conduit and gutters in the model for space coordination with other trades as well as determining backing.
   • **Raceways - Required** for coordination with other trades.

11. **Requested by USC Information Technology Services:**
   a. **Underground OSP System**
      a) Conduits size
      b) Conduits number
      c) Conduit locations
      d) Trench line location
      e) Conduit depths and details
      f) MH locations
      g) MH size
      h) MH details/cable layout splice locations
      i) Copper cable type, size
      j) Copper cable ID #
      k) Copper cable splice cases
      l) Fiber cables type, size
      m) Fibers ID #
      n) Fiber splice cases
   b. **Building Inside Cable Supports Infrastructures**
      a) OSP conduits entering MDF room.
      b) Riser system from main telecom room to other telecom rooms. Amount, size and route.
      c) MDF room size location and layouts.
      d) Other Telecom room size and layout.
      e) Conduits, sleeves, stub up conduits, boxes, cable trays and their location and sizes.
      f) Telecom Jack locations, wall mounted floor mounted.
      g) Telecom outlets types, quad, duplex, single, rack mount patch panels.
      h) Wi-Fi location and cable.
      i) Telecom room’s power outlet locations.
      j) Telecom room ground Bus Bar.
      k) Telecom room AC location and size.
      l) All associated supports (wire and/or rods).
      m) Distributed Antenna System (DAS).
      n) Cable or satellite TV.
      o) Security cameras.
      p) Building or site emergency phones.
      q) Area of refuge phone requirement.
APPENDIX B: BIM DATA ACQUISITION GUIDELINE FOR FACILITIES MANAGEMENT SERVICES

The information below is meant to provide guidance on the following:

- Capturing of attribute data related to equipment / building system(s), that which USC Facilities Management Services deems of importance to on-going operations.
- Minimum modeling requirements / standards in the development of models (BIM) for a new building construction project.
- Anticipated deliverables (from the design and construction teams), as associated with their respective modeling efforts.
- Goals and broad deliverables associated with the transfer of project information in a COBie compliant fashion.
- Recommended workflows anticipated to aid in the delivery on all of the above mentioned items, and that which may be considered in a subsequent project BIM Implementation Plan.

For context USC has identified the following goals and practical benefits for leveraging BIM within Facilities Management Services.

- FM Enterprise Information System “Data Population”.
- Timely and accurate management of project turn over/documentation.
- Management and updating of evolving building space.

MASTER ATTRIBUTES

Within the BIM authoring application, the following (type or instance) parameter fields shall be populated, either centrally in the model or applied to individual MEP+F system families. The fields that are to be populated with USC designated information may be left empty if that information is not yet available.

**NOTE:** The field names must appear EXACTLY as shown. Use the Shared Parameter TXT file below:
## USC MASTER ATTRIBUTES

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<th>REVIT PARAMETER NAME</th>
<th>Description</th>
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<td>USC Floor Number</td>
<td>USC Floor Designation</td>
</tr>
<tr>
<td>USC Equipment Number</td>
<td>USC Equipment Number</td>
</tr>
<tr>
<td>USC ESMID</td>
<td>Unique Id assigned to selected pieces of USC equipment for Energy Management purposes</td>
</tr>
<tr>
<td>Number</td>
<td>USC Room Number designation</td>
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<tr>
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<td>USC Room Name designation</td>
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## USC NOMENCLATURE

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<td>Corresponding OmniClass description to the OmniClass number</td>
</tr>
<tr>
<td>Uniformat Number</td>
<td>Corresponding product’s UniFormat number</td>
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<tr>
<td>Master Format Number</td>
<td>Corresponding products’s Master Format number</td>
</tr>
<tr>
<td>Type Name</td>
<td>According to USC Nomenclature Guideline</td>
</tr>
<tr>
<td>Type Description</td>
<td>According to USC Nomenclature Guideline</td>
</tr>
<tr>
<td>Instance Name</td>
<td>According to USC Nomenclature Guideline</td>
</tr>
<tr>
<td>Instance Description</td>
<td>According to USC Nomenclature Guideline</td>
</tr>
</tbody>
</table>

### ASSET MANAGEMENT ATTRIBUTES

Specification and performance type data, typically found in an equipment schedule, shall be captured within the design models. Provisions for these parameter fields, for doing so shall be maintained when developing families.

See attached exhibit entitled **USC FMS MEP Outline Schedule Data Specifications.pdf**, (organized by Master Format 2004 Specification Format) for required equipment specific MEP+F type parameters. These fields are to be established as at the start of modeling, and subsequently updated through the progression of design and construction.
These exhibits are the beginning of what will be an evolving list, and shall be expanded once it is determined that additional types of equipment (not covered) are to be specified and installed in subsequent phases of construction.

**SPACE MANAGEMENT OBJECTIVES**

For the purpose of allowing Facilities Management Services to carry out downstream space management related functions, at minimum the following objects shall be modeled (and not massed) so to be able to enclose an area and represent all rooms. The intent is to solicit such information as (1) square footage, (2) heights, and (3) volumes.

1. Walls
2. Floors
3. Roofs
4. Windows
5. Doors
6. Ceilings
7. Shafts (stairs, elevators, etc)

**COBie**

**Information Tiers**

For the purpose of categorizing data that would eventually be delivered in a COBie compliant format, the following tiers have been established.

1. **Tier #1**: Master Attributes + Asset Management Attributes  
   It is anticipated that these will be found and maintained (throughout the project) within the design models.

2. **Tier #2**: Balance of information required of COBie  
   It is anticipated that these shall be found and maintained (throughout the project) within the agreed upon depository of COBie worksheets.

3. **Tier #3**: Project close-out documents  
   It is anticipated that these shall be found and maintained (throughout the project) within the agreed upon depository of COBie worksheets.
COBie standard worksheets

The following COBie standard worksheets shall be provided (at minimum) to meet the long term Facilities Management goals. The standard fields within these respective sheets shall be consistent with the current COBie 2 standards.

a. Design models:
   1. Contact
   2. Facility
   3. Floor
   4. Space should be classified using OmniClass and Net Area is provided (Gross Area is generated by Revit).
   5. Zones should have categories assigned.
   6. Types should have Name, Category (OmniClass), Description, AssetType.
   7. Components should have Name, Description, Type and Space.
   8. Systems should have Name, Category (OmniClass), Components.
   9. Document
   10. Attribute (see Tier#1 for minimum requirements)

b. Construction models
   1. Type information updated by providing manufacturer, model number, warranty information (parts and labor and duration), replacement cost.
   2. Component information updated by providing serial number, installation date, warranty start date, tag number and/or barcode. Installation date for major equipment will be the finish date of the scheduled activity.
   3. Spare parts provided for types.
   4. Attributes provided for types and components.

c. Commissioning Models
   1. Attributes corrected based on real measurements.
   2. Documents linked to COBie worksheet.

COBie update schedule

It is anticipated that the master COBie compliant worksheet is updated to reflect the available information at the following stages in a project.

- 100% Design Documents (validation of Tier#1 fields provided)
- Issuance of “For Construction”
- 75% Substantial Completion
- Commissioning Complete
- Project Close-Out
APPENDIX C: NOMENCLATURE
(updated 2/18/2012)

Families, Types, Instances (Components), Systems and Zones Naming Requirements

INDUSTRY CODES

USC requires the use of the latest version* of OmniClass as the coding standard.
*http://www.omniclass.org/about.asp (for latest version)

OmniClass Table 23 Products are used to digitally code and classify Equipment Type & Components.
- For example, 23-27 21 11 is the digital code for equipment axial flow compressors.

OmniClass Table 21 Elements are used to digitally code and classify Equipment Systems and Zones.
- For example, 21-51 31 11 17 is the digital code for equipment system named Domestic Water Distribution.

EQUIPMENT FAMILY, TYPE AND INSTANCES (COMPONENTS) NOMENCLATURE

- Naming conventions for equipment types should be succinct, useful and descriptive. The names provided should allow for easy identification and be easily understood in order to facilitate the operation, repair and maintenance of USC equipment.

- USC uses a combination of Industry Standard nomenclature - OmniClass Table 23 Products, the U.S. National CAD Standards (NCS) 3.1 Module 5 : Terms and Abbreviations and an Equipment Operation Description to name equipment types and instances as illustrated below. Please follow this guide accordingly:

For example: Variable Air Volume (VAV) Box with ID D01, the Type and Instance Names:

FAMILY NAME
Variable Air Volume Terminal Units

TYPE NAME
VAV Box Reheat 6 Inches

INSTANCE NAME
VAV - D01
**TYPE DESCRIPTION**
U.S. National CAD Standards (NCS) 3.1 Module 5: Terms and Abbreviations
+ Equipment Operation Description
  + Extended description denoting manufacturer /type/size as easily identified & understood

**INSTANCE DESCRIPTION**
U.S. National CAD Standards (NCS) 3.1 Module 5: Terms and Abbreviations
+ Detailed Equipment Operation Description
Extended Description denoting type/size/id/location unique to that instance

For example: Variable Air Volume (VAV) Boxes the Type and Instance Descriptions:

**TYPE DESCRIPTION**
VAV
+ with Reheat Price SDV 6 Inches

VAV with Reheat Price SDV 6 Inches

**INSTANCE DESCRIPTION**
VAV
+ with Reheat 6 Inches
  + D01

with VAV Reheat 6 Inches D01

HELP FILES

Execution of Equipment Family, Type and Instances (Components) Nomenclature
Details on how to populate the nomenclature in Autodesk® Revit describing the parameters to use, where to place them, and relevant examples, can be found in the documents entitled "USC Nomenclature & Systems.ppt" and "USC Revit Parameters List.xls" which are located in the subfolder named “BIM Guidelines Reference Docs” in the “Project Documentation” folder in e-Builder.

An Autodesk® Revit shared parameters file is also available in e-Builder to populate Autodesk® Revit files with the USC required parameters and/or with the creation of Revit families.
SYSTEMS NOMENCLATURE

USC uses a combination of the Industry Standard nomenclature OmniClass Table 21 Elements, the U.S. National CAD Standards (NCS) 3.1 Module 5: Terms and Abbreviations and an Equipment Operation Description to name systems as illustrated below. Please follow this guide accordingly.

**Execution of Systems and Zones Nomenclature**

Further illustration and relevant examples of USC conforming systems and zones nomenclature can be found in the documents entitled “USC Nomenclature & Systems.ppt” which are located in the sub-folder named “BIM Guidelines Reference Docs” in the “Project Documentation” folder in e-Builder.

For example: Supply Air System for Air Handling Unit (AHU) D-1 = Mechanical Supply Air AHU-D1

For systems that are not directly connected to a piece of equipment, follow the convention below:
For example: Ductless return air system consisting of pieces of ductwork and a return air grille, "RG -1"=
Mechanical Return Air RG-1 2nd Floor 214A Office

21-04 30 60 20
Return Air
+ Disciplne "Mechanical"
Mechanical Return Air

RG-1 + 2nd Floor 214A Office
SYSTEM NAME
Mechanical Return Air RG-1 2nd Floor 214A Office

ZONES NOMENCLATURE

In order to identify zones USC uses a combination of the U.S. National CAD Standards (NCS) 3.1 Module 5: Terms and Abbreviations, an Equipment Operation Description and USC official Room Numbers to name zones as illustrated below. Please follow this guide accordingly:

U.S. National CAD Standards (NCS) 3.1 Module 5 : Terms and Abbreviations
+ Equipment Operation Description
Description denoting size / type as easily identified

USC official Room Name and Numbers for rooms contained in that Zone

ZONE NAME

For example: The HVAC Zone associated with VAV Box D01 serving Offices 100,101,102 =
VAV-D01 Offices 100,101,102

VAV + equipment number from schedule (i.e. D01)
VAV-D01

Office 100, 101, 102
ZONE NAME
VAV-D01 Offices 100,101,102

SPACES

Spaces should be named according the official USC room numbers as provided by Space Management.
APPENDIX D: Installation Change Log

Where installation differs from the coordinated model, a log of adjusted installations will be kept detailing what the change was, the reason for the change and confirming that the 3D model has been updated accordingly. The following template can be used for this purpose.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION OF CHANGE</th>
<th>REASON FOR CHANGE</th>
<th>DATE OF MODEL UPDATE</th>
<th>CHANGED BY:</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
APPENDIX E: Revit Model Requirements and Warnings

The following represents the Revit model requirements and Revit warnings to correct.

- Overlapping of design elements (especially walls and room boundaries).
- All floors are subdivided by room.
- Space enclosures. All spaces must be bounded by walls and floors.
- Every space has a name and a room number, including all shafts and stairs.
- There is only one space instance per space, no duplicates.
- Resolve all orphans (resulting from using “copy/paste”).
- All walls are connected to the top of slab at bottom and bottom of slab at top (if full height).
- All mechanical spaces are defined floor to floor, unless there is a plenum.
- Plenums are defined as a separate space.
- All mechanical systems are defined (every element belongs to a system). This can be verified using the Revit MEP system browser.
- Sidewall diffusers are placed in defined spaces and attached to corresponding walls.
- Ensure that the Revit MEP file is linked to the Revit architectural file. (This can be checked by using the Revit System Browser and verifying that the space name and space number columns are populated).
- Ensuring that all system components within a workset belong to that workset.
- Ensuring that all mechanical zones are defined.
- Ensuring that there are no unassigned components (View/User Interface/System Browser).
- Mapping MEP space names to architectural room names.
APPENDIX F: Collision Detection and Design Review

The best methodology for tracking collision issues is to save named viewpoints for each clash in a dated folder. Sharing this collision checked file with other Design Team members allows individuals to review issues that pertain to them in a systematic way. This should be done by the BIM Facilitator using an iterative process:

- Clash detection*
  - MEPF against structure
  - MEPF against MEPF
  - MEPF against FFE
  - FFE against structure
- Visual inspection
  - Cross-sectioning through building
  - Viewing ceilings from below for MEPF penetrations
  - MEPF anomalies with architecture
  - Architectural and structural misalignment
  - Ceilings elevations relative to fenestration
  - Etc.
- Save viewpoints (in a folder for that date)
- Review issues with the Design Team
- Each discipline resolves issues pertaining to their discipline
- Re-clash
- Move resolved issue viewpoints to a “Resolved” folder
- Create new viewpoints for new issues in a dated folder
- Review previous unresolved issues and new issues
- Resolve issues
- Re-clash...

*This is best done in the collision detection software such as Navisworks, not in Revit.
APPENDIX G: USC FMS Outline Schedule Data Specification

Section 22 06 10
Schedules for Plumbing Piping and Pumps

[SUMP / SEWAGE EJECTOR] PUMP SCHEDULE

- Tag
- Manufacturer
- Model Number
- Location
- Service
- Fluid
- Type / Configuration
- Basin Size
- Inlet Size
- Discharge Size
- Design Flow Rate (GPM)
- Total Design Head
- RPM
- Minimum Efficiency (%)
- Impeller Size (as applicable)
- Motor Data
  - Break Horse Power
  - Horse Power
  - Rotations Per Minute
  - Voltage
  - Phase
  - Hertz
- Operation Weight
- Master Format Reference Number
- Uni-Format Reference Number
- USC Equipment Reference Number

Section 22 06 30
Schedules for Plumbing Equipment

HOT WATER GENERATOR SCHEDULE

- Tag
- Service
- Manufacturer
- Model Number
- Location
- Type
- Storage Capacity (Gallons)
- Recovery Capacity (Flow @ ΔT)
- Outlet Water Supply Temperature
- Outlet Water Supply Flow
- Recovery Capacity (Flow @ ΔT)
- Operating Weight
- Master Format Reference Number
- Uni-Format Reference Number
- USC Equipment Reference Number
Section 22 06 40
Schedules for Plumbing Fixtures

FIXTURE SCHEDULE

- Tag
- Fixture Type
- Water Demand “Fixture Unit”
  - Cold Water
  - Hot Water
- Waste Demand “Fixture Unit”
- Branch Pipe Connections
  - Waste
  - Trap
  - Vent
  - Cold
  - Hot
- Master Format Reference Number
- Uni-Format Reference Number
- USC Equipment Reference Number

Section 23 06 20
Schedules for HVAC Piping and Pumps

PUMP SCHEDULE

- Tag
- Manufacturer
- Model Number
- Location
- Service
- Fluid
- Type / Configuration
- Inlet Size
- Discharge Size
- Design Flow Rate
- Total Design Head
- RPM
- Minimum Efficiency (%)
- Impeller Size (as applicable)
- Motor Data
  - Break Horse Power
  - Horse Power
  - Rotations Per Minute (RPM)
  - Voltage
  - Phase
  - Hertz
- Operation Weight
- Master Format Reference Number
- Uni-Format Reference Number
- USC Equipment Reference Number
Section 23 06 30
Schedules for HVAC Air Distribution

FAN SCHEDULE

- Tag
- Manufacturer
- Model Number
- Location
- Area Served
- Service
- Type
- Configuration
- CFM
- External Static Pressure
- Total Static Pressure
- Wheel Diameter (Inches)
- Rotations Per Minute
- Motor Data
  - Break Horse Power
  - Horse Power
  - Rotations Per Minute
  - Voltage
  - Phase
  - Hertz
- Operating Weight (Lbs)
- Master Format Reference Number
- Uni-Format Reference Number
- USC Equipment Reference Number

AIR TERMINAL UNIT (Constant / Variable)

- Tag
- Manufacturer
- Model Number
- Area Served
- Central System Serving
- Inlet Size (Inches)
- CFM
  - Maximum
  - Minimum (as applicable)
- Other (as applicable) Maximum Pressure Drop
- Re-heat Coil (See requirements listed elsewhere in specification section)
- Branch Pipe Size
- Operating Weight
- Discharge NC
- Radiated NC

RE-HEAT COIL SCHEDULE

- Tag
- Manufacturer
- Model Number (as applicable)
- Location
- Area Served
- Coil Area (Sq. Ft)
- CFM
• Total Capacity (MBH)
• Minimum Rows Deep
• Coil Construction Material
• Fins Per Inch (as applicable)
• Fin Construction Material
• Air Conditions
  o Entering Dry Bulb Temp.
  o Leaving Dry Bulb Temp.
• GPM
• Water Conditions
  o Entering Dry Bulb Temp.
  o Leaving Dry Bulb Temp.
  o Maximum Pressure Loss - Air Side
  o Water Side

DIFFUSER / REGISTER SCHEDULE

• Tag
• Manufacturer
• Model Number
• Material
• Finish
• Type
• Mounting
• Nominal Dimensions (in. X in.)
• Inlet / Neck Dimensions (in. X in.)
• Maximum Static Pressure
• Throw Pattern
• Maximum Design Air Flow
• Minimum Design Air Flow
• Throw @ Maximum Design Air Flow
• Throw @ Minimum Design Air Flow
• Noise Criteria @ Max Air Flow
• Border Type
• Master Format Reference Number
• Uni-Format Reference Number
• USC Equipment Reference Number

SOUND ATTENUATOR SCHEDULE

• Tag
• Manufacturer
• Model Number
• Location
• Dimensions
  o Width
  o Height
  o Length
• CFM
• Maximum Pressure Drop
• Minimum Dynamic Insertion Loss (In Db) +1000 FPM
  o 63 Hz
  o 125 Hz
  o 250 Hz
  o 500 Hz
  o 1 KHz
  o 2 KHz
### AIR HANDLING UNIT

- Tag
- Manufacturer
- Model Number
- Location
- Area Served
- Supply & Return Fan(s)
  - CFM
  - External Static Pressure (Inches WC)
  - Total Static Pressure (Inches WC)
  - Rotations Per Minute (RPM)
  - Motor Data
    - Break Horse Power
    - Horse Power
    - Rotations Per Minute
    - Voltage
    - Phase
    - Hertz
  - Wheel Diameter (Inches)
- Cooling / Heating Coil
  - Maximum Face Velocity (FPM)
  - Coil Area (Sq. Ft)
  - CFM
  - Total Capacity (MBH)
  - Sensible Capacity (MBH) "as applicable"
  - Minimum Rows Deep
  - Coil Construction Material
  - Fins Per Inch
  - Fin Construction Material
  - Entering Air Conditions
    - Dry Bulb Temp.
    - Wet Bulb Temp.
  - Leaving Air Conditions
    - Dry Bulb Temp.
    - Wet Bulb Temp.
  - GPM
  - Water Conditions
    - Entering Temp.
    - Leaving Temp.
    - Maximum Pressure Loss (Psi / FT)
- Air Side
- Water Side

- Filters
  - Quantity
  - Size
  - Type
  - Minimum Effective (%)
  - Minimum MERV

- Operational Weight (Lb)
- Minimum Outside Weight (Lb)
- Master Format
- Uni Format
- USC Equipment Number

Section 23 06 80
Schedules for Decentralized HVAC Equipment

COMPUTER ROOM AIR CONDITIONING UNITS

- Tag
- Manufacturer
- Model Number
- Location
- Area Served
- Supply Fan
  - CFM
  - External Static Pressure
  - Total Static Pressure
  - Rotations Per Minute
  - Motor Data
    - Break Horse Power
    - Horse Power
    - Rotations Per Minute
    - Voltage
    - Phase
    - Hertz

- Cooling Coil
  - Maximum Face Velocity (FPM)
  - Coil Area (Sq. Ft)
  - Total Capacity (MBH)
  - Sensible Capacity (MBH)
  - Entering Air Conditions
    - Dry Bulb Temp. (*F)
    - Wet Bulb Temp. (*F)
  - Leaving Air Conditions
    - Dry Bulb Temp (*F)
    - Wet Bulb Temp (*F)
  - Flow Rate (GPM)
  - Water Temperature
    - Entering Conditions (*F)
    - Leaving Conditions (*F)
  - Max. Pressure Loss / Drop (Psi / Ft.)

- Filters
  - Quantity
  - Size
  - Type
  - Minimum Efficiency %

- Minimum MERV
- Humidifier
o Manufacturer (if different from unit manufacturer)
  o Model Number
  o Type
  o Capacity

• Unit Electrical Data
  o FLA
  o MCA
  o MOCP
  o Volts
  o Phase
  o Hertz

• Operating Weight
• Master Format Number Reference Number
• Uni-Format Reference Number
• USC Equipment Reference Number

FAN-COIL UNITS

• Tag
• Manufacturer
• Model Number
• Location
• Area Served
• Supply Fan
  o CFM
  o External Static Pressure
  o Total Static Pressure
  o Rotations Per Minute
  o Motor Data
    ▪ Break Horse Power
    ▪ Horse Power
    ▪ Rotations Per Minute
    ▪ Voltage
    ▪ Phase
    ▪ Hertz

• Cooling / Heating Coil
  o Maximum Face Velocity (FPM)
  o Coil Area (Sq. Ft)
  o Total Capacity (MBH)
  o Sensible Capacity (MBH)
  o Minimum Rows Deep
  o Coil Construction Material
  o Fins Per Inch
  o Fin Construction Material
  o Entering Air Conditions
    ▪ Dry Bulb Temperature (°F)
    ▪ Wet Bulb Temperature (°F)
  o Leaving Air Conditions
    ▪ Dry Bulb Temperature (°F)
    ▪ Wet Bulb Temperature (°F)
  o Flow Rate (GPM)
  o Water Temperature
    ▪ Entering Condition (°F)
    ▪ Leaving Conditions (°F)
  o Max. Pressure Loss / Drop (Psi / Ft.)
    ▪ Air Side
    ▪ Water Side

• Filters
  o Quantity
- Size
- Type
- Minimum Efficiency (%)
- Minimum MERV

- Unit Electrical Data
  - FLA
  - MCA
  - MOCP
  - Volts
  - Phase
  - Hertz

- Operating Weight
- Minimum Outside Air (CFM)
- Master Format Reference Number
- Uni-Format Reference Number
- USC Equipment Reference Number

---

**RADIANT PANEL SCHEDULE**

- Tag
- Manufacturer
- Model Number (as applicable)
- Area Served
- Total Panel Area (Sq.Ft.)
- Total Panel Area (Sq.Ft.) – Heating Only
- Total Panel Area (Sq.Ft.) – Cooling Only
- Radiant System Pump Number
- Flow Rate (GPM)
  - Heating
  - Cooling
- Room Operating Conditions
  - Space Temperature Set Point
    - Heating (°F)
    - Cooling (°F)
  - Supply Air Temperature Set Point
    - Heating (°F)
    - Cooling (°F)

- Cooling
  - Specified Panel Capacity (Btu/H / Sq.Ft)
  - Total Capacity (Btu/H)
  - Minimum Surface Temperature (°F)
  - Radiant Supply Temperature (°F)
  - Radiant Return Temperature (°F)

- Heating
  - Specified Panel Capacity (Btu/H / Sq.Ft)
  - Total Capacity (Btu/H)
  - Minimum Surface Temperature (°F)
  - Radiant Supply Temperature (°F)
  - Radiant Return Temperature (°F)

- Operating Weight
- Master Format Reference Number
- Uni-Format Reference Number
- USC Equipment Reference Number

---

**RADIANT FLOOR SCHEDULE**

- Tag
• Manufacturer
• Model Number
• Location
• Fluid
• Radiant System Pump Number
• Flow Rate (GPM)
• Radiant Panel Area (Sq.Ft)
• Surface Resistance
• Loop
  o Total Tube Length (Ft)
  o Maximum Loop Length (Ft)
  o Maximum Pressure Drop
  o Tube Type
  o Tube Outside Diameter (Inches)
  o Tube Spacing (Inches)
• Cooling
  o Specified Space Capacity (Btu/H / Sq.Ft)
  o Short Wave Capacity (Btu/H / Sq.Ft)
  o Total Capacity (Btu/H)
  o Minimum Surface Temp. (°F)
  o Radiant Supply Temp. (°F)
  o Radiant Return Temp. (°F)
• Heating
  o Specified Space Capacity (Btu/H / Sq.Ft)
  o Short Wave Capacity (Btu/H / Sq.Ft)
  o Total Capacity (Btu/H)
  o Minimum Surface Temp. (°F)
  o Radiant Supply Temp. (°F)
  o Radiant Return Temp. (°F)
• Maximum Flow Rate (GPM)
  o Heating
  o Cooling
• Master Format Reference Number
• Uni-Format Reference Number
• USC Equipment Reference Number

Section 26 06 20
Schedules for Low Voltage Electrical Distribution

ELECTRICAL PANEL SCHEDULE

• Panel Name
• Panel Location
• Fed From
• Voltage
• Phase
• Wire
• Main Circuit Breaker
  o Yes
  o No
  o Main Circuit Breaker Size (If Yes Above)
• Bus Size
• Type of Mounting
  o Surface
  o Flush
• Isolated Ground Bus
  o Yes
  o No
• Shunt Trip
  o Yes
  o No
• Neutral Size
  o 100%
  o 200%
• Feed Through
  o Yes
  o No
• Master Format Reference Number
• Uni-Format Reference Number
• USC Equipment Reference Number

Section 26 06 50
Schedules for Lighting

LIGHTING FIXTURE SCHEDULE

• Type
• Description
• Fixture Manufacturer
• Fixture Catalogue / Model Number
• Finish
• Mounting
• Lamp
  o Type
  o Manufacturer
  o Catalogue / Model Number
  o Quantity
  o Input Wattage
• Voltage
• Master Format Reference Number
• Uni-Format Reference Number
• USC Equipment Reference Number (as applicable)
APPENDIX H: ECODOMUS

The following describes the process used for implementing EcoDomus on USC projects.

1. Configure COBie QC template

USC will set up the Data Acquisition Template in EcoDomus PM, to provide a baseline that all COBie2 requirements can be measured against in the automated QC process. OmniClass based rules are set for the attributes, naming conventions, and documentation, allowing for easy integration of the data with other data sets with the same classification system.

2. Populate Project Equipment Database

The construction team will populate extended properties and documentation provided in shop drawings and equipment schedules for the installed equipment in EcoDomus PM. This equipment data will be attached by batch to the relevant objects in the uploaded BIM.
3. Load Geometry Validated BIM into EcoDomus PM

Once the geometry of the BIM has been verified to accurately reflect the as-built conditions, USC will load the BIM into EcoDomus using the Revit EcoDomus plug-in. This process includes synching with Revit in the EcoDomus PM desktop, and then a data push to the EcoDomus PM web application.

Geometry Validated Model

EcoDomus - Revit plug-in

3D Interface in EcoDomus with all integrated data

4. Perform COBie Quality Control

The Project Equipment Database will be attached to the model in EcoDomus in an automated process to ensure efficiencies of the BIM data population. Once the data is attached to the associated objects in the model, it will be validated via a quality control process to ensure compliance with COBie and data requirements.

Missing Attributes report (COBie data check)
Any missing information generated in the report will be checked in the field using mobile devices, and against corresponding shop drawings and schedules provided by the project team. Data will then be added in the corresponding object field in EcoDomus web or client application.

Enter field data directly against 3D object or in associated web form

5. **Populate Complete Data Set to Revit - “Augmented BIM”**
   The accumulated, verified data can be pushed back into the geometrically verified Revit model using the EcoDomus Revit plug-in.
APPENDIX I

BUILDING INFORMATION MODELING (BIM) EXECUTION PLAN
VS 1.0

FOR
[PROJECT TITLE]

DEVELOPED BY
[AUTHOR COMPANY]
# TABLE OF CONTENTS

| SECTION A: | BIM PROJECT EXECUTION PLAN OVERVIEW |
| SECTION B: | PROJECT INFORMATION |
| SECTION C: | KEY PROJECT CONTACTS |
| SECTION D: | BIM PROCESSES AND COLLABORATION PROCEDURES |
| SECTION E: | BIM AND FACILITY DATA REQUIREMENTS |
| SECTION F: | BIM AND DATA QUALITY CONTROL |
| SECTION G: | MODEL STRUCTURE |
| SECTION H: | PROJECT DELIVERABLES |
| SECTION I: | ATTACHMENTS |
SECTION A: BIM PROJECT EXECUTION PLAN OVERVIEW

This BIM Project Execution Plan defines uses for BIM on the project (e.g. design authoring, cost estimating, and design coordination), along with a detailed design of the process for executing BIM throughout the project lifecycle.

[INSERT ADDITIONAL INFORMATION HERE IF APPLICABLE. FOR EXAMPLE: BIM MISSION STATEMENT This is the location to provide additional BIM overview information. Additional detailed information can be included as an attachment to this document.]
SECTION B: PROJECT INFORMATION

This section defines basic project reference information and determined project milestones.

1. **PROJECT OWNER:**

2. **PROJECT NAME:**

3. **PROJECT LOCATION AND ADDRESS:**

4. **CONTRACT TYPE / DELIVERY METHOD:**

5. **BRIEF PROJECT DESCRIPTION:** [NUMBER OF FACILITIES, GENERAL SIZE, ETC]

6. **ADDITIONAL PROJECT INFORMATION:** [UNIQUE BIM PROJECT CHARACTERISTICS AND REQUIREMENTS]

7. **PROJECT NUMBERS:**

<table>
<thead>
<tr>
<th>PROJECT INFORMATION</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>USC CONTRACT NUMBER:</td>
<td></td>
</tr>
<tr>
<td>USC PROJECT NUMBER:</td>
<td></td>
</tr>
<tr>
<td>USC SITE CODE:</td>
<td></td>
</tr>
<tr>
<td>USC BUILDING NUMBER:</td>
<td></td>
</tr>
</tbody>
</table>

8. **PROJECT SCHEDULE / PHASES / MILESTONES:**

Include BIM milestones, pre-design activities, major design reviews, stakeholder reviews, and any other major events which occur during the project lifecycle.

<table>
<thead>
<tr>
<th>PROJECT PHASE/MILESTONE</th>
<th>ESTIMATED START DATE</th>
<th>ESTIMATED COMPLETION DATE</th>
<th>PROJECT STAKEHOLDERS INVOLVED</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCHEMATIC DESIGN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50% CONSTRUCTION DOCUMENTS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FACILITIES MANAGEMENT SERVICES REVIEW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100% CONSTRUCTION DOCUMENTS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SECTION C: KEY PROJECT CONTACTS

List each of the lead BIM contacts for each organization on the project. Additional contacts can be included later in the document.

USC’s e-Builder Project Management Information System (PMIS) will be used for the storage and access of all contract documents including BIMs. Permissions will be set up by USC. Please indicate whether the project contacts listed below will require access to e-builder.

<table>
<thead>
<tr>
<th>ORGANIZATION</th>
<th>CONTACT NAME</th>
<th>ROLE</th>
<th>E-BUILDER ACCESS REQUIRED Y/N</th>
<th>LOCATION</th>
<th>E-MAIL</th>
<th>PHONE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
SECTION D: BIM PROCESSES AND COLLABORATION PROCEDURES

1. Collaboration Strategies and BIM Processes
   Describe the collaboration strategies and detailed processes used for developing, coordinating and leveraging the BIMs for the following purposes (as applicable). List the project team participants required for each:

   a. Existing conditions – determining control points, how the data is collected (laser scanning, or other)
   b. Design reviews
   c. Design coordination
   d. Design assist (GMAX contracts only)
   e. Energy analysis
   f. Construction coordination
   g. Design model updates during construction
   h. Engagement of USC departments
   i. Record modeling
   j. Estimating
   k. Other (describe)

2. Model Delivery Schedule, Application and File Exchange Type
   Document the information exchanges and file transfers that will occur on the project.

<table>
<thead>
<tr>
<th>DISCIPLINE</th>
<th>BIM USE</th>
<th>ONE-TIME or FREQUENCY</th>
<th>DUE DATE or START DATE</th>
<th>MODEL FILE</th>
<th>MODEL SOFTWARE</th>
<th>NATIVE FILE TYPE</th>
<th>VERSION</th>
<th>FILE EXCHANGE TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARCHITECTURE</td>
<td>DESIGN AUTHORING</td>
<td>WEEKLY</td>
<td>20___ ___</td>
<td>ARCH</td>
<td>Revit</td>
<td>.RVT</td>
<td></td>
<td>.RVT .DWG .NWC</td>
</tr>
<tr>
<td>ARCHITECTURE</td>
<td>3D COORDINATION</td>
<td>WEEKLY</td>
<td>[DATE]</td>
<td>COORD</td>
<td>Navisworks</td>
<td>.NWD .NWF</td>
<td></td>
<td>.NWD .XYZ .ABC</td>
</tr>
<tr>
<td>STRUCTURE</td>
<td></td>
<td>WEEKLY</td>
<td>[DATE]</td>
<td>STRUCT</td>
<td>DESIGN APP</td>
<td>.XYZ</td>
<td></td>
<td>.XYZ .ABC</td>
</tr>
<tr>
<td>MECHANICAL</td>
<td></td>
<td>WEEKLY</td>
<td>[DATE]</td>
<td>MECH</td>
<td>DESIGN APP</td>
<td>.XYZ</td>
<td></td>
<td>.XYZ .ABC</td>
</tr>
</tbody>
</table>

3. Interactive Workspace and Communication Technology
   The project team should consider the physical environment it will need throughout the lifecycle of the project to accommodate the necessary collaboration, communication and reviews that will improve the BIM Plan decision making process. Describe how the project team will be located. Consider questions like “will the team be collocated?” If so, where is the location and what will be in that space? Will there be a BIM Trailer? If yes, where will it be located and what will be in the space such as computers, projectors, tables, table configurations. If not co-located, what communication technology (Webex, Gotomeeting, etc.) will be implemented?
SECTION E: BIM AND FACILITY DATA REQUIREMENTS

Describe the methodologies to be used to fulfill the USC FMS data requirements as described in the body of this document.
SECTION F: BIM AND DATA QUALITY CONTROL

Describe the strategy to control the quality of the model and the checks to be performed to assure quality.

<table>
<thead>
<tr>
<th>CHECKS</th>
<th>DEFINITION</th>
<th>RESPONSIBLE PARTY</th>
<th>SOFTWARE</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>VISUAL CHECK</td>
<td>Ensure there are no unintended model components and the design intent has been followed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTERFERENCE CHECK</td>
<td>Detect problems in the model where two building components are clashing including soft and hard.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STANDARDS CHECK</td>
<td>Ensure that the BIM standards have been followed (filenaming, discipline colors, etc...)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODEL INTEGRITY CHECKS</td>
<td>Describe the QC validation process used to ensure that the Project Facility Data set has no undefined, incorrectly defined, incorrectly named or duplicated elements and the reporting process on non-compliant elements and corrective action plans.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REVIT WARNINGS CHECKS</td>
<td>Etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SECTION G: MODEL STRUCTURE

1. **File Naming Structure:**

   **File Names for Models Should Be Formatted As:**

   BUILDING ACRONYM _ CONSTRUCTION (CON) OR DESIGN PHASE _ LEVEL _ DISCIPLINE _ ORGANIZATION _ DATE (YEAR-MONTH-DAY)

<table>
<thead>
<tr>
<th>Model Type</th>
<th>Format Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architectural Model</td>
<td>XYZ_50%CD* <em>ARCH</em> LXX_ZXY_?????-??-??</td>
</tr>
<tr>
<td>Civil Model</td>
<td>XYZ_50%CD <em>CIV</em> LXX_ZXY_?????-??-??</td>
</tr>
<tr>
<td>Mechanical (HVAC) Model*</td>
<td>XYZ_50%CD <em>HVAC</em> LXX_ZXY_?????-??-??</td>
</tr>
<tr>
<td>Mechanical (Pipe) Model*</td>
<td>XYZ_50%CD <em>MECH</em> LXX_ZXY_?????-??-??</td>
</tr>
<tr>
<td>Plumbing Model*</td>
<td>XYZ_50%CD <em>PLBG</em> LXX_ZXY_?????-??-??</td>
</tr>
<tr>
<td>Fire Sprinkler*</td>
<td>XYZ_50%CD <em>FIRE</em> LXX_ZXY_?????-??-??</td>
</tr>
<tr>
<td>Electrical Model*</td>
<td>XYZ_50%CD <em>ELEC</em> LXX_ZXY_?????-??-??</td>
</tr>
<tr>
<td>Structural Model (Steel)*</td>
<td>XYZ_50%CD <em>STEEL</em> LXX_ZXY_?????-??-??</td>
</tr>
<tr>
<td>Structural Model (Concrete)*</td>
<td>XYZ_50%CD <em>CONC</em> LXX_ZXY_?????-??-??</td>
</tr>
<tr>
<td>Structural Model (Rebar)</td>
<td>XYZ_50%CD <em>REBAR</em> LXX_ZXY_?????-??-??</td>
</tr>
<tr>
<td>Coordination Model</td>
<td>XYZ_50%CD <em>COORD</em> LXX_ZXY_?????-??-??</td>
</tr>
</tbody>
</table>

   *50%CD could be 100%CD or DD or SD, for example.
   *CON during construction

   For example: ANN_CON_HVAC_L01_GFC_2012-03-15

2. **Model Structure:**

   Describe and diagram how the model is separated, e.g., by building, by floor, by zone, by area, and/or by discipline.

3. **Measurement and Coordinate Systems:**

   Describe the measurement system (Imperial or Metric) and coordinate system (geo-referenced) used.

4. **Model Accuracy and Tolerances:**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Discipline</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Documents</td>
<td>Arch</td>
<td>Accurate to +/- [#] of actual size and location</td>
</tr>
<tr>
<td>Shop Drawings</td>
<td>Mech Contractor</td>
<td>Accurate to +/- [#] of actual size and location</td>
</tr>
</tbody>
</table>
# SECTION H: PROJECT DELIVERABLES

<table>
<thead>
<tr>
<th>BIM SUBMITTAL ITEM</th>
<th>STAGE</th>
<th>APPROXIMATE DUE DATE</th>
<th>FORMAT</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Development</td>
<td>Close out</td>
<td>(.xyz)</td>
<td></td>
<td>See Record Model Information Exchange to ensure that the proper information is contained in this model</td>
</tr>
<tr>
<td>Construction</td>
<td>Close out</td>
<td>(.xyz)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Documents</td>
<td>Close out</td>
<td>(.xyz)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


SECTION I: ATTACHMENTS
List the supporting attachments that are supplementary to this BIM Execution Plan.
GLOSSARY

COBie:
(Construction Operations Building Information Exchange) COBie is an information exchange specification for the life-cycle capture and delivery of information needed by facility managers. COBie can be viewed in design, construction, and maintenance software as well as in simple spreadsheets.

BIM Execution Plan:
The BEP defines the uses for BIM on a project along with a detailed process for executing BIM.

Geo-referencing:
A system that links information to a position on the earth’s surface. That is, establishing its location in terms of map projections or coordinate systems.

e-Builder:
USC’s Project Management Information System. The repository for all USC construction project information.

NWF:
Navisworks file where only a list with pointers to the files currently loaded is saved, along with the scene’s environment, the current view, clash results, if available, and favorite viewpoints (including redlines and comments). To open an NWF file, a Navisworks product is required, such as Review, Simulate, or Manage (not Freedom), as well as access to the original CAD files.

NWD:
The published version of a Navisworks file with all loaded models and viewpoints saved to a single (NWD) file. This file type can be opened with any of the Navisworks products including Navisworks Freedom (the free viewer).

NWC:
When you open a CAD file in Navisworks, by default, a corresponding cache file (NWC) is created, which contains all of the conversion details required by Navisworks. To open an NWC file, a Navisworks product is required, such as Review, Simulate, or Manage (not Freedom). Certain Applications, like Revit, will export the corresponding model to an NWC file.

IFC:
The Industry Foundations Classes is an open, neutral and standardized specification for Building Information Models.

DWG:
DWG ("drawing") is a binary file format used for storing two and three dimensional design data and metadata. It is the native format for several CAD packages. In addition, DWG is supported natively by many other CAD applications.

Shared parameters:
Shared parameters are parameters that you can add to families or projects and then share with other families and projects. They give you the ability to add specific data that is not already predefined in the family file or the project template.

Co-Location:
The assembling of the entire BIM design and construction team in a single location to enable instant and direct communication and coordination. Co-Location of all team members provides the environment and opportunity to build trust among teammates, while efficiently designing the
Project issues are transparent and solutions evolve in real time because everyone is working in the same physical space.

**Model Mash-up:**
The process of overlaying as built fabrication BIMs with as designed BIMs in order to compare differences in order to adjust the design BIMs to as-built conditions.

**Omniclass:**
The *OmniClass* Construction Classification System (known as OmniClass™ or OCCS) is a classification system for the construction industry. It incorporates other extant systems currently in use as the basis of many of its Tables – MasterFormat™ for work results and UniFormat for elements.

**UniFormat:**
UniFormat, a publication of CSI and CSC, is a method of arranging construction information based on functional elements, or parts of a facility characterized by their functions, without regard to the materials and methods used to accomplish them. These elements are often referred to as systems or assemblies.

**MasterFormat:**
MasterFormat, a publication of CSI and CSC, is a master list of numbers and titles classified by work results. It is primarily used to organize project manuals and detailed cost information, and to relate drawing notations to specifications.

**Consolidated model:**
An assembled model containing all of the project models in one file.
REFERENCES

Indiana University BIM Guidelines


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The Computer Integrated Construction Research Program. PennState Department of Architecture and Engineering

The National BIM Standards-US

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Jay Simons – USC Office of the University Architect
Igor Starkov- President, EcoDomus, Inc.

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