

State of Tennessee Office of the State Architect (TN OSA)

Building Information Modeling Standards (BIMs)

Version 2.1

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1. Introduction

1.1. Mission of the TN OSA BIM Standards

The mission of the State of Tennessee Office of the State Architect (TN OSA) BIM Standards is to utilize consistent *Building Information Modeling* (BIM) technology standards to create building projects with greater long term owner value through a collaborative design, construction and operations process.

1.2. Purpose and Application of the TN OSA BIM Standards

The TN OSA has established these BIM Standards for the consistent development and management of BIM on State designated BIM projects. For projects designated by the State, or State Procurement Agency (SPA) to use BIM, these BIM Standards apply to designers and their consultants, and/or to contractors and their subcontractors, qualified by the State Procurement Agencies (SPAs).

On State projects not designated to use BIM, the designers and/or contractors may voluntarily choose, on their own, to use BIM. The State encourages designers and contractors using BIM on projects, where BIM is not a State requirement, to adopt these BIM Standards. Designers and contractors using BIM on projects, where BIM is not a State requirement, may deliver BIMs, in addition to paper documents, for the aspects of the project for which they have followed these BIM Standards.

The goal of these BIM Standards is to be outcome-based. It is not the intent of the State to prescribe the means, methods or software products by which designers and/or contractors meet these BIM Standards.

This Tennessee (TN) Building Information Modeling Standard (BIMs) encompasses the development of the following BIM project deliverables: See Sections 3.12 and 5.11 for more information on designer and contractor deliverables by project phase.

TN OSA BIMs DELIVERABLES

| BIM / COBie DELIVERABLE* | PROJECT PHASE OF DELIVERY |
|--|------------------------------------|
| BIM Execution Plans (See Appendices A and F) | See Sections 3.9 and 5.8 |
| Design BIMs | See Sections 3.12.1.5 and 3.12.1.6 |
| Construction BIMs | Project Close Out |
| COBie Worksheets | Project Close Out |

**Additional BIM requirements, deliverables, and exchanges not required by these BIM Standards may be identified for project delivery by the owner in the BIM Execution Plan (BEP).*

2. General Principles and Definitions

2.1. Ownership and Rights of Data

Refer to SBC-6a Terms and Conditions for Agreement between Owner and Designer Section 6.1 and AIA Document A201 Sections 1.5, 1.7 and 1.8 regarding ownership, digital data use, data transmission and BIM reliance.

BIM and CAD files are not *Contract Documents*. Differences may exist between these files and the corresponding *Contract Documents*. Where discrepancies arise between BIM or CAD files and the *Contract Documents*, the *Contract Documents* shall govern.

2.2. Risk Allocation

Each Project Team member is responsible for any contribution to a BIM or CAD file made by them or by any other Project Team member for whom they are responsible. Each Project Team member shall exercise the same standard of care in their use of BIM and CAD files including the development, exchange, transmission and interoperability of these files. Protocols for such use shall be defined in the BIM Execution Plan (BEP). See Appendices A and F.

No party is entitled to rely on any BIM or CAD file to provide the level of detail required to accurately take off any quantities for any specific project materials or components, unless expressly stated in the BIM Execution Plan (BEP). See Appendices A and F.

2.3. Definitions

- **Asset:** A *BIM Object* such as *Space* or *Equipment* that has *Attributes* associated with it. See Appendices C and D.
- **Asset Category:** A classification of *Assets* organized by their functional and/or systemic relationships. See Appendix D.
- **Attribute:** Properties associated with *BIM Objects* such as *Spaces* and *Equipment*. See Appendices C and D.
- **Building Information Model (BIM):** Digital representation of the physical and functional characteristics of a building.¹
- **BIM - Drawing Equivalency:** For these BIM Standards, this BIM methodology maintains that a drawing at ¼" = 1'-0" or smaller, that is published from a BIM by the designer for inclusion in *Contract Documents*, is a direct representation of that BIM.

¹ The National BIM Standard – United States Version 3

2.3. Definitions (Continued)

- **BIM Execution Plan (BEP):** This plan lays out how BIM will be implemented and which goals or BIM uses will be pursued on the project as a result of the decisions of the *Project Team*.² This is a living document that is updated at key milestones during the project. In most cases, there will be one BEP developed by the design team and a second BEP developed by the contractor. See Appendices A and F for an outline and minimum BEP content.
- **BIM Process Map:** A diagram showing how BIM will be applied on a project including associated activities and information exchanges.³ See Appendix G.
- **BIM Object:** An element, such as a *Space* or a piece of *Equipment* within a BIM, which has properties associated with the object.
- **Construction BIMs:** BIMs generated by the contractor, the contractor's subcontractors, and major suppliers, typically representing a single building system. BIM objects are accurate in terms of size, shape, location, quantity and orientation and may include fabrication, assembly, detailing and non-geometric information. These BIMs are updated throughout the construction phase to include but not limited to addenda, architect's supplemental instructions, change orders and construction change directives. Construction BIMs include facility management data required by the owner per Table E1 and Section 5.1.
- **Construction Operations Building information exchange (COBie):** Format for the exchange of information about building *Assets* such as *Equipment*, products, materials, and *Spaces*.
- **Construction Operations Building information exchange (COBie) Worksheets:** Spreadsheet format of *COBie*.
- **Contract Documents:** See AIA Document A201, Section 1.1.1.
- **Coordination BIM:** Coordinated by the contractor, this composite BIM includes multiple *Design BIMs* and/or *Construction BIMs*, registered spatially, used for the purposes of coordination during construction.

² BIM Handbook, 2008

³ National BIM Standard – United States® Version 3

2.3. Definitions (Continued)

- **Design BIMs:** BIMs produced by the designer and the designer’s consultants, from which construction documents phase drawings are to be published. This BIM is updated during the bidding and negotiation phases to include all changes from addenda, including accepted alternates. Design BIMs are updated throughout the construction phase to include but not limited to addenda, architect’s supplemental instructions, change orders and construction change directives. Design BIMs include facility management data required by the owner per Table E1 and Section 3.1.
- **Equipment – Building Assets** such as conveying systems, plumbing, electrical, fire suppression, HVAC and other installed equipment. See Appendix D, Table D2.
- **Equipment Component:** Each physical instance of a piece of equipment within a BIM having specific *Attributes* associated with it. See Appendix D.
- **Equipment Inventory:** A complete list of the building *Equipment* and their *Attributes*, delivered in *COBie* format. See Appendices D and E.
- **Equipment Type:** A unique *Equipment* object representing a single manufacturer and model number. See Appendix D.
- **Equipment Type ID:** An abbreviation used to identify an *Equipment Type*. This is a BIM parameter that is identical to the *TNID*. See Appendix D.
- **IFC** - The Industry Foundation Class specification is a neutral data format developed and maintained by buildingSMART International used to describe, exchange and share information typically used within the building information modeling and facility management industry sector.
- **Project Team:** The project owner, parties in privity with the owner, and additional parties not in privity with the owner, who are contributing services and/or materials to the project.
- **Shared Parameters File:** A file for Revit that meets the *Asset Attribute* requirements of these BIM Standards. *Project Teams* can use this file to assign TN-required *Asset Attributes* to their Revit objects. This file is configured specifically for use in adding COBie-related parameters and is not meant to replace existing parameters used in preparation of the construction documents.
- **Space:** A space object within a BIM having specific *Attributes* associated with it. See Appendix C.

2.3. Definitions (Continued)

- **Space Inventory:** A complete list of building *Spaces* and their *Attributes*, as specified in Appendices C and E, delivered in *COBie* format.
- **TNID:** An abbreviation used to identify a unique *Asset*. For the TN BIMs, the TNID is a parameter that is identical to the *Asset Type ID*. The TNID is necessary to implement the *TN-Specific Rule Set Model Checker*. See Appendix D.
- **TNNamingSystem:** This is a spreadsheet provided to designers via the OSA website that enables designer's to use custom Type ID's that can be validated using the TN OSA COBie Validator. See Appendix D, *Equipment Naming Standards and Attributes*.
- **TN OSA COBie Validator:** A validation tool provided by the State of Tennessee to assist in verifying that a project's *COBie* file meets the State of Tennessee BIM Standards.
- **TN-Specific Rule Set Model Checker:** A Model Checker for Revit provided by the State of Tennessee to assist designer's, designer's consultants, contractors and subcontractors in verifying that all required *Equipment* names and *Attributes* have been applied as Revit parameters per Appendix D.

3. BIM Requirements for Designers

3.1. Building Information Modeling Scope

The following disciplines must produce *Design BIMs*.

- Architectural - ARCH
- Structural - STR
- Mechanical - MECH
- Plumbing - PLBG
- Electrical - ELEC
- Other specialties required by the SPA or owner
- Civil* - CVL
- Landscape* - LND
- Low Voltage* - LV
- Fire Protection*,** - FP

NOTE: The discipline abbreviations above are provided for file naming purposes. See *Section 3.12 BIM Deliverables by Phase - Designer*.

*While BIM models are encouraged for this discipline, 3D CAD or dwg formats are acceptable when approved by the SPA or owner and documented in the BEP. While preferred, it is not required that the COBie data be maintained in the *Design BIMs* for this discipline.

**Fire protection elements included in the *Design BIM* shall be sufficient to comply with the *State of Tennessee Standard of Care for Fire Sprinkler System Design*. This shall include mains, branch piping, and heads required to provide preliminary hydraulic calculations associated with most remote zone; size, type, and locations of standpipes and risers; and fire pump and associated piping and required accessories.

The designer and the designer's consultants shall use BIM authoring software to generate BIMs that include the geometry, physical characteristics, and data needed to extract the *Contract Documents* and to produce the required BIM and COBie deliverables.

Unless otherwise indicated in these BIM Standards, the level of development required by the disciplines identified above is at the discretion of the design team. The designers should use their professional judgment in determining the level of development required to provide the normal and contractual information required at each phase in conjunction with these BIM Standards.

The designer and the designer's consultants shall update the *Design BIMs* throughout design and construction in accordance with these BIM Standards. The designer shall make the *Design BIMs* available to the contractor and owner in accordance with these BIM Standards and as described in the *BEP*. See Section 3.8.

For the *Design BIMs*, the space and equipment naming shall be in accordance with Appendices C, D and E of these BIM Standards prior to being provided to the contractor and prior to delivery to the owner.

3.2. Compliance with IFC and COBie

The BIM authoring software shall be compliant with the Industry Foundation Classes (IFC) Coordination View⁴ and should be able to export to the Construction-Operations Building information exchange (COBie) format, which is based on the IFC Facility Management (FM) Handover View⁵. The major BIM authoring software applications are IFC and COBie compliant. If unsure whether the BIM authoring software meets this requirement or how to export to IFC and COBie formats, contact the BIM authoring software vendor.

3.3. Open Standards and Collaboration

The owner encourages the use of open software standards (e.g., IFC, COBie) and collaboration tools to facilitate interoperability among the *Project Team*.

3.4. Building Number

A campus, department or agency may assign building numbers as required. For STREAM projects that are new construction, an 8-digit Building ID # may be assigned. This number may be provided by the State of Tennessee Project Manager.

3.5. Geo-referencing

The designer and the designer's consultants shall geo-reference BIMs, site plans and associated construction drawings to allow interoperability with existing State of Tennessee Geographic Information Systems (GIS). BIMs, site plans and associated construction drawings shall be registered to the Tennessee State Plane Coordinate System⁷. Coordinates for any site may be requested from Office of Information Resources, GIS Services (OIR GIS). The Tennessee State Plane Coordinates are comprised of:

- The North American Datum of 1983 (NAD83) and the North American Vertical Datum of 1988 (NAVD 88).

The BIMs shall include:

- A marker for the registration point and identify the rotation and origin of rotation from Project North to True North. Geo-referencing shall be maintained throughout the design of the project; and
- A polyline or other BIM-equivalent outline representing the building footprint of the lowest floor of the lowest enclosed area including basement. An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement area, is not considered a building's lowest floor. For further clarification see the Federal Emergency Management Agency's (FEMA) definition of lowest floor⁶.

⁴ buildingSMART 2013

⁵ East and Chipman 2011

⁶ FEMA 2012

⁷ See Change Log Page 57 Item 31

3.6. Existing Conditions

The designer and the designer's consultants shall model any existing conditions that are needed to describe the design of the project. The designer shall work with the owner to determine the extent of the existing conditions necessary for the design.

Where the owner provides a BIM of the existing conditions, no guarantee is implied as to the accuracy of dimensions or building features shown and users of the models assume full responsibility for verifying the accuracy of such models to the extent that elements represented within the model are visually observable. Where existing conditions provided in a BIM are not visually observable, the designer shall define a strategy to field verify the existing conditions determined necessary for the design.

3.7. Staffing

For each project, the designer shall identify a qualified BIM manager that is capable of managing the BIM deliverables, through the close-out phase, from all disciplines required by Section 3.1 of these BIM Standards. The designer's consultants using BIM shall each identify a BIM coordinator that is capable of managing the BIM deliverables of that specific discipline or firm.

The names, contact information and responsibilities of the BIM manager and the BIM coordinators shall be documented in the *BEP*.

3.8. File Sharing System

The owner shall be provided access to the designer's secure, web-based file sharing system. The files for which the owner is provided access including their associated read/write privileges shall be defined in the *BEP*.

The BIM models for which the owner is provided access including their associated project milestones shall be defined in the *BEP*.

For projects with special information technology (IT) security requirements, the owner may provide a secure, web-based file sharing system for the project.

Any special protocols necessary to access and/or utilize the secure, web-based file sharing system should be documented in the *BEP*.

3.9. BIM Execution Plan (BEP)

The designer and the designer's consultants along with the designer's BIM manager shall develop a *BEP* that identifies the protocols for the development and management of BIMs during the design phases. The *BEP* is a living document, which will be augmented and updated as design progresses. Thus, there are multiple *BEP* milestones as follows.

Appendix A includes the minimum topics that shall be addressed in the designer's *BEP*. Special project types may require additional topics.

3.9.1. Phased BEP Development and Contents

3.9.1.1. Schematic Design Phase (SDP)

Add to the agenda for SDP review meeting the topic: “Discuss BIM Execution Plan”.

During SDP, the designer shall submit for owner review and approval, a *BEP* that, at a minimum, covers the following topics (See Appendix A for detailed information required under each topic):

- Project Information;
- Project designer and designer’s consultants Information; and
- BIM Goals and Objectives
- Roles and Responsibilities
- Collaboration and File Sharing Plan
- Software for Model Authoring
- Planned Models
- Modeling Standards
- Sign-Off

3.9.1.2. Design Development Phase (DDP)

Add to the agenda for DDP Review Meeting the topic: “Discuss BIM Execution Plan”.

During the DDP, the designer shall update and extend the *BEP* and submit it for owner review and approval. The DDP *BEP* shall include all topics included in the SDP *BEP*, with any updates highlighted. It shall also include the following additional topics (See Appendix A for detailed information required under each topic):

- Model Analysis Plan; and
- Project Construction Documents Phase

3.9.1.3. Construction Documents Phase (CDP)

Add to the agenda for CDP review meeting the topic: “Submit BIM Execution Plan, as performed”.

During the CDP, the designer shall update and extend the *BEP* to reflect the BIM execution process as performed then submit it to the owner.

3.10. BIM-Based Analyses

The State of Tennessee BIM Standards recommends BIM for the following analyses described in Sections 3.10.1 through 3.10.3. These BIM Standards require that BIMs be used for the application of Contact, Facility, Floor, *Space* and Type/Component (*Equipment*) names and their *Attributes*. See Appendices C, D and E.

3.10.1. Program Validation

Designers should use BIMs to validate that the design complies with the general requirements of the owner's program.

3.10.2. Energy Analysis

BIMs should be used as the basis for energy modeling and analysis when required. Appendix B of this document provides guidance on preparing a BIM for export for energy analysis.

3.10.3. Clash Detection

The designer and the designer's consultants are required to coordinate their designs. The design team should use the BIMs and automated interference/clash detections to confirm that building system interferences have been identified and resolved within the applicable standard of care so that the occupiable space by these building systems is adequate and that the systems can be integrated while maintaining serviceability and accessibility.

The State of Tennessee provides resources through the OSA website to assist designers and designer's consultants in conducting automated interference/clash detections.

3.10.4. Contact, Facility, Floor and Space - Naming and Attributes

BIMs shall be used as the basis for applying the required Contact, Facility, Floor and *Space Attributes* in accordance with these BIM Standards. *Spaces* shall be named, classified, tagged and assigned *Space Attributes* per Appendix C.

3.10.5. Type/Component (Equipment) Naming and Attributes

BIMs shall be used as the basis for applying the designer-required Type/Component (*Equipment*) naming system and *Attributes* per Appendices D and E of these BIM Standards. See Section 3.10.6 for more information on applying and verifying *Equipment* names and *Attributes*. Any *Attribute* values not required to be provided by the designers may be left blank but the *Attribute* parameter shall be included in the *Design BIM Equipment* object properties.

3.10.6. Equipment Attributes – Applying and Verifying

The TN OSA provides resources available at the TN OSA website to assist designers, designer's consultants and contractors in applying and verifying Type/Component (*Equipment*) names and *Attributes* in accordance with Appendix D.

3.10.6. Equipment Attributes – Applying and Verifying (Continued)

- A *Shared Parameters File* is provided to assist designers and contractors using Autodesk Revit software in applying all required COBie Type/Component (*Equipment*) names and *Attributes* as Revit parameters. Any *Attribute* values not required to be provided by the designers may be left blank but the *Attribute* shall be included in the *Design BIM Object* properties. For example, design engineers are not required to provide the refrigerant type for chillers in their *Design BIM*. However, they are required to apply and maintain an *Attribute* called “RefrigerantType” in their *Design BIM* chiller objects.
- A *TN-Specific Rule Set Model Checker* for Revit is provided to assist designers, designer’s consultants and contractors in verifying that all required *Equipment Attributes* have been applied as Revit parameters per Appendix D. To run these checks, a Type Parameter called *TNID* must be applied to the *Equipment* object properties in the Revit model. The value of the *TNID* Parameter is identical to the *Equipment Type ID* in Appendix D, Table D2 – Column 4 (i.e., For a Chiller, the *Asset Type ID* = CH and the *TNID* = CH).
- The TN OSA COBie Validator is a validation tool provided by the State of Tennessee to assist in verifying that a project's *COBie* file meets the State of Tennessee BIM Standards.

3.11. BIM Methodology

The following methodology is required for all disciplines creating BIMs.

- a) The designer, the designer’s consultants and the contractor shall geo-reference BIMs, site plans and associated construction drawings to allow interoperability with existing State of Tennessee Geographic Information Systems (GIS). See Section 3.5.
- b) All BIMs shall be geometrically and dimensionally accurate in both 2D and 3D: plan, elevation, and section views. In addition, BIM elements shall be represented by the correct object types in order to provide accurate reporting of building *Assets* and their *Attributes*.
- c) Parametric links shall be maintained within the models to allow the automatic publication of plans, sections, elevations, schedules, and 3D views where used in contract drawings.

3.11. BIM Methodology (Continued)

- d) All drawings shall be direct representations of the BIM in accordance with the *BIM-Drawing Equivalency*. The intent of requiring that drawings not be modified after publication is to preserve the continuity of the BIM model geometry as related to its depiction in the drawings. This continuity is defined as the *BIM - Drawing Equivalency*. The designer shall not modify these documents after publication in a manner as to disassociate the *BIM - Drawing Equivalency*. Typical drawing modifications and enhancements necessary to convey the design intent are acceptable.
- e) Information needed to generate *Contract Documents* shall be graphically and alphanumerically included in and derived from the BIMs. All drawings - plans, sections, and elevations – in addition, schedules and 3D views shall be published from the BIMs *in accordance with the BIM-Drawing Equivalency*.
- f) Unless required by the *BIM-Drawing Equivalency*, details at scales larger than the $\frac{1}{4}'' = 1'-0''$ are not required to be included in the BIMs. For such plans, sections, and elevations, the use of standard Computer Aided Drawing (CAD) details is acceptable provided that the elements shown in model act as the basis for these drawings.
- g) All BIMs shall be organized by discipline and floor. Some models may be delivered in 3D dwg format with no custom objects. See Sections 3.1 and 5.1.
- h) BIMs shall be used to apply and maintain the required *COBie Attribute* parameters and values as required by Appendices C, D and E of these BIM Standards.
- i) Where communications between the designer and contractor result in changes or additions to drawings, schedules or 3D views (e.g., addenda), the *BIMs* shall be updated and the drawings published therefrom in accordance with the *BIM-Drawing Equivalency*.

3.12. BIM Deliverables by Phase - Designer

The following BIM deliverables to the owner are required by the designer and designer's consultants.

Designer - BIM Deliverables and File Standards

| BIM Deliverable | File Type |
|--------------------|--|
| BIM Execution Plan | . pdf format |
| Design BIMs | BIMs in .ifc file format / See Section 3.1 |

Designer - BIM Execution Plan File Naming Convention

| Agent_Deliverable | Character | Project Phase | Character | Bldg. # | Character | File Extension |
|-------------------|-----------|---------------|-----------|---------|-----------|----------------|
| DES_BEP | _ | XX | _ | ##### | . | pdf |

Example: *DES_BEP_DD_19000061.pdf*

Designer - BIM Deliverable File Naming Convention

| Discipline Abbreviation | Character | BIM Type | Character | Project Phase | Building # | Character | File Extension |
|-------------------------|-----------|----------|-----------|-------------------------------|------------|-----------|----------------|
| XXXX | _ | DBIM | _ | CD's (CDP) or Close Out (CLS) | ##### | . | ifc and dwg |

Example: *ARCH_DBIM_CD_19000061.ifc*
LND_DBIM_CLS_19000061.dwg
**MEFP_DBIM_CLS_19000061.ifc*

NOTE: See Section 3.1 for a list of discipline abbreviations to use in the *Design BIM* file name.

NOTE: The required drawings referred to in Section 3.12 are described in the Terms and Conditions for Agreement between Owner and Designer.

*NOTE: Multi-disciplinary Models: Combinations of mechanical, electrical, plumbing and/or fire protection models may be delivered as a single, multi-disciplinary model. When multi-disciplinary models are delivered, the abbreviations below shall be included in the file name.

- Mechanical (M)
- Electrical (E)
- Fire Protection (F)
- Plumbing (P)

3.12.1.1. Program Verification Phase

- Submit *BEP*.

3.12.1.2. Schematic Design Phase (SDP)

- Submit *BEP*.

3.12.1.3. Design Development Phase (DDP)

- Submit *BEP*.
- Submit all required drawings.
 - All drawings required to be provided during the DDP shall be published from the *Design BIMs* in accordance with Section 3 of these BIM Standards.
 - Contact, Facility, Floor, *Space* and Type/Component (*Equipment*) Attributes including *Attribute* values shall be applied to the *BIM Objects* in the *Design BIMs*, and be tagged in the drawings, per Appendices C, D and E of these BIM Standards. See Appendix E, Table E1 for the designer-required *Attributes* to be applied to the *Design BIMs*.

3.12.1.4. Early Design Phase Presentation (EDP)

- If an EDP is required, it should adhere to Section 3.11 where applicable. The presentation may be enhanced using other software.

3.12.1.5. Construction Documents Phase (CDP)

- Submit *BEP*.
- Submit all required drawings.
 - All drawings required to be provided during the CDP shall be published from the *Design BIMs* in accordance with Section 3 and Appendices C, D and E of these BIM Standards.
 - Validated Contact, Facility, Floor, *Space* and Type/Component (*Equipment*) Attributes including validated *Attribute* values shall be applied to the *BIM Objects* in the *Design BIMs*, and be tagged in the drawings, per Appendices C, D and E of these BIM Standards. See Appendix E, Table E1 for the designer-required *Attributes* to be applied to the *Design BIM*.
 - Submit *Design BIMs* to the owner in accordance with these BIM Standards.

In the *Design BIMs*, any *Equipment Attribute* values not required to be provided by the designers may be left blank but the *Attribute* shall be applied and maintained in the *Design BIM Object* properties per Appendices D and E. See Section 3.10.6 for information on tools provided by TN OSA to assist in the application and verification of *Equipment Attributes*.

3.12.1.6. Bid Phase (BP)

- Submit all required drawings.
 - All revised drawings required during the Bid Phase shall be published from the revised *Design BIMs* in accordance with Section 3 and Appendices C, D and E of these BIM Standards.
 - All revised Contact, Facility, Floor, *Space* and Type/Component (*Equipment*) *Attributes* including *Attribute* values shall be applied to the *BIM Objects* in the *Design BIMs*, and be tagged in the drawings, per Appendices C, D and E of these BIM Standards. See Appendix E, Table E1 for the designer-required *Attributes* to be applied to the revised *Design BIMs*.
- Submit revised *Design BIMs* to the owner in accordance with these BIM Standards.

3.12.1.7. Construction Administration Phase (CA)

- Where any communications with the contractor involve changes or additions to drawings, schedules or 3D views (e.g., addenda), the *Design BIMs* shall be updated and any drawings published therefrom in accordance with the *BIM-Drawing Equivalency*.
- Review shop drawings from the contractor. While these drawings may be published from BIMs, the BIMs may **not** be submitted for review in lieu of 2D drawings.

3.12.1.8. Project Closeout Phase (CLS)

- Review the final *Design BIMs* to verify that they incorporate all changes made by the designer including but not limited to addenda, architect's supplemental instructions, change orders, construction and change directives as formally modified throughout the construction process.
- Confirm that all designer-required Contact, Facility, Floor, *Space* and Type/Component (*Equipment*) *Attributes* including names, values and tags are validated and have been applied to *Design BIMs* per these BIM Standards. See Appendix E, Table E1.
- Submit *the Design BIMs* to the owner in accordance with these BIM Standards.

4. The BIM Process for Designers

1. Project awarded
2. Prime: Assign BIM manager.
3. Consultant(s): Assign BIM coordinator.
4. Ascertain the building number(s) and Tennessee State Plane coordinates for the project.
5. Develop, expand and update the *BEP* from SDP through CDP. Refer to *BEP* outline in Appendix A for required content.
6. Set up secure, web-based file sharing system.
7. Finalize program verification.
8. Prepare BIM authoring tool.
 - a. If using Revit
 - i. From the OSA website, download and install all add-ons and/or plugins necessary to export required IFC deliverables.
 - ii. From the OSA website, download the custom TN *Shared Parameters File*. See Section 3.10.6.
 - b. From the OSA website, download the *TN-Specific Rule Set Model Checker* for Revit. If using other authoring software, contact software vendor for support.
9. Develop *Design BIMs*:
 - a. Populate model with *BIM Object* library content updated to contain TN required *Asset* names and *Attributes*. See Appendix E, Table E1 for designer-required Contact, Facility, Floor, *Space* and Type/Component (*Equipment*) *Attributes*.
 - b. The *Model Checker for Revit* may be used to perform validation check on the *Design BIM* to confirm the proper application of *Equipment Attributes*.
10. BIM-based analyses should be performed per Section 3.10 of these BIM Standards.
11. During Construction Documents Phase: (See Section 3.12.1.5)
 - a. Update *Design BIMs* including Contact, Facility, Floor, *Space* and/or Type/Component (*Equipment*) names and *Attributes* to reflect addenda and accepted alternatives.
 - b. Submit *Design BIMs* in accordance with these BIM Standards.. See Section 3.1.
12. During Bidding Phase: (See Section 3.12.1.6)
 - a. Update *Design BIMs* including Contact, Facility, Floor, *Space* and Type/Component (*Equipment*) names and *Attributes* to reflect any required changes to the construction documents including any addenda and/or accepted alternates.
 - b. Submit any revised *Design BIMs* in accordance with these BIM Standards. See Section 3.1.

4. The BIM Process for Designers (Continued)

13. During Construction Administration: (See Section 3.12.1.7)
 - a. Use the *Design BIMs* to produce addenda and other appropriate change documents and provide updated *Design BIMs* to the contractor at intervals and in format(s) agreed upon by the designer and contractor in the *BEP*.
 - b. Review shop drawings from the contractor.
 - c. Review product data provided by the contractor.
 - d. Review the information provided in the contractor's *COBie* document worksheets for conformance to the *Contract Documents*.
14. At Project Closeout: (See Section 3.12.1.8)
 - a. Review *COBie* worksheets for conformance to the *Contract Documents*.
 - b. Review and submit *the Design BIMs* in accordance with these BIM Standards.. See Section 3.1.

5. BIM Requirements for Contractors

5.1. Building Information Modeling Scope

The following trades that shall produce *Construction BIMs*:

- Structural Steel - STRS
- Other Fabrication* - FAB (Optional)
- Mechanical (HVAC) - MECH
- Mechanical (HVAC Pipe) - MECHP
- Plumbing - PLBG
- Electrical - ELEC
- Fire Protection** - FP
- Pneumatic Tube - PT
- Building Automation Systems** - BAS
- Low Voltage** - LV
- Civil** - CVL
- Other trades required by the SPA or owner

NOTE: The discipline abbreviations above are provided for file naming purposes. See *Section 5.11 BIM Deliverables - Contractor*.

*Other Fabrication is optional.

**While *BIM* models are encouraged for this discipline, 3D CAD or dwg formats are acceptable when approved by the SPA or owner and documented in the *BEP*. The *COBie* data for these disciplines is required to be included in the final *COBie* deliverables at project close-out. While preferred, it is not required that the *COBie* data be maintained in the *Construction BIMs* for this discipline.

5.1 Building Information Modeling Scope (Continued)

Design BIMs will be provided by the designer to the contractor in a file format as outlined in the *BEP*.

The BIMs created or modified by the construction team are the *Construction BIMs*. The *Construction BIMs* shall include *Asset* names and *Attributes* per Appendices C, D and E. The nomenclature should be identical to those in the *Design BIMs* provided by the designer in accordance with Appendices C and D, unless there are approved changes.

The level of development required by the disciplines identified above is at the discretion of the contractor. The contractor, the contractor's subcontractors and suppliers should use their professional judgment in determining the level of design required to provide the normal and contractual information required at each phase in conjunction with these BIM Standards.

The contractor, the contractor's subcontractors and suppliers shall use BIM authoring software to develop the required *Construction BIMs* which shall be used in conjunction with the designer-provided *Design BIMs* to allow an accurate BIM context to perform BIM-based coordination. See Section 5.9.1.1.

The contractor, contractor's subcontractors and suppliers shall continuously update and maintain the *Construction BIMs* throughout construction to include but not limited to addenda, architect's supplemental instructions, change orders and construction change directives. During construction, the contractor shall make available to the owner, upon request, up-to-date *Coordination BIMs and/or Construction BIMs* in IFC format.

5.2. Compliance with IFC and COBie

All required trades shall use 3D modeling software. The BIM authoring software shall be compliant with the Industry Foundation Classes (IFC) Coordination View⁴ and should be able to export to the Construction-Operations Building information exchange (COBie) format, which is based on the IFC Facility Management (FM) Handover View⁵ above. The major BIM authoring software applications are IFC and COBie compliant. If unsure whether the BIM authoring software meets this requirement or how to export to IFC and COBie formats, contact the BIM authoring software vendor.

5.3. Open Standards and Collaboration

The owner encourages the use of open software standards (e.g., IFC, COBie) and collaboration tools to facilitate interoperability among the *Project Team*.

5.4. Building Number

A campus, department or agency may assign building numbers as required. For STREAM projects that are new construction, an 8-digit Building ID # may be assigned. This number may be provided by the State of Tennessee Project Manager.

5.5. Geo-referencing

The contractor is required to geo-reference all site plans, and *Construction BIMs* to allow interoperability with existing TN GIS. BIMs provided to the contractor from the designer, should already be geo-referenced. See Section 3.5.

5.6. Staffing

The contractor shall identify a qualified BIM manager for each project that is capable of managing the BIM deliverables from all subcontractors and major suppliers during the construction, through the close-out phase of the building project. Each party that is creating a *Construction BIM* shall identify a BIM coordinator. The BIM coordinator is responsible for managing the BIM deliverables of that specific subcontractor or supplier.

The names, contact information, and responsibilities of the BIM manager and the BIM coordinators shall be documented in the *BEP*.

5.7. File Sharing System

The owner may designate a secure, web-based file sharing system for use by the contractor. If the owner does not designate a secure, web-based file sharing system for use by the contractor, then the contractor shall provide a secure, web-based file sharing system. The contractor shall ensure that the secure, web-based file sharing system conforms to any IT or security requirements required by the owner. Any special protocols necessary to access and/or utilize the secure, web-based file sharing system shall be documented in the *BEP*. The contractor shall provide on-site hardware and software to view individual and merged BIMs as well as clash detection results.

The owner shall be provided access to the contractor's secure, web-based file sharing system. The files for which the owner is provided access including their associated read/write privileges shall be defined in the *BEP*. See Section 5.8.

The BIM models and versions for which the owner is provided access shall be defined in the *BEP*. See Section 5.8.

5.8. BIM Execution Plan (BEP)

The contractor and contractor's BIM manager shall develop, with input from all parties providing *Construction BIMs*, *BEP* that identifies the protocols for the development and management of BIMs during the construction phase, as well as the turnover of the BIMs and *COBie* data at project closeout. Appendix F includes the minimum topics that shall be addressed in the *BEP* for construction.

The *BEP* is a living document, which will be augmented and updated as design progresses. Thus, there are multiple *BEP* milestones as follows. Each *BEP* milestone submission requires a sign-off from all team members with BIM and/or *COBie* responsibility.

5.8.1. Phased BEP Development and Contents

5.8.1.1. Mobilization

During mobilization, the contractor shall submit for owner review and approval, a *BEP* that, at a minimum, covers the following topics (See Appendix F for detailed information required under each topic):

- Project Information;
- Project Construction Team Information;
- BIM Goals and Objectives;
- Roles and Responsibilities;
- Software for Model Authoring;
- Modeling Standards and Content;
- Construction Phase Analyses;
- BIM Kickoff Meeting date, location and agenda; and
- Sign-Off.

5.8.1.2. Following BIM Kickoff Meeting, before Coordination

Following BIM kickoff meeting, the contractor shall update and extend the *BEP* and submit for owner review and approval. This *BEP* shall include all topics included above, with any updates highlighted. It shall also include the following additional topics (See Appendix F for detailed information required under each topic):

- Collaboration and File Sharing Plan;
- BIM Coordination;
- BIM Coordination Meetings;
- *COBie* Coordination; and
- *COBie* Coordination Meetings.

5.8.1.3. Substantial Completion

At substantial completion the contractor shall update and extend the *BEP* and submit for owner review and approval. This *BEP* shall include all topics included above, with any updates highlighted. It shall also include the following additional topics (See Appendix F for detailed information required under each topic):

- BIM Deliverables

5.9. BIM-Based Analyses

5.9.1.1. Coordination

- The schedule and the detailed protocols of the BIM-based coordination process shall be included in the *BIM Execution Plan*.
- BIMs should be used to identify and resolve spatial interferences between building systems and products prior to fabrication and field installation. The contractor should determine any additional building elements, temporary structures, etc. required for coordination.
- The contractor shall include clearances for maintenance and other access, code clearances, and other required clearances in the interference checking.
- On a periodic basis, the contractor shall schedule and manage on-site coordination meetings to resolve interferences. The contractor shall publish and make available reports identifying the statuses of the interferences and the coordination progress.

5.9.1.2. Fabrication and Installation

- Coordinated *Construction BIMs* shall be used to fabricate building components and systems for at least those trades required by Section 5.1 of these BIM Standards to produce BIMs.

5.9.1.3. 4D BIM

The contractor and subcontractors should use *Construction BIMs* for additional analyses including:

- Logistical planning and layout and
- 4D scheduling, where 4D scheduling is a 3D geometric model linked to a schedule.

5.9.1.4. Contact, Facility, Floor and Space - Naming and Applying Attributes

- The contractor shall maintain the Contact, Facility, Floor names and *Attributes* including *Space* types, classifications, tags, names and *Attributes* that were developed in the *Design BIM* in accordance with these BIM Standards.

5.9.1.5. Equipment Naming and Applying Attributes

- The contractor shall maintain the Type/Component (*Equipment*) classifications, types, tags, names and *Attributes* that were developed in the *Design BIM* in accordance with Appendix D.
- The contractor shall add any Type/Component (*Equipment*) objects that were not modeled by the designer, but are required per Appendices D and E. Where *Equipment* objects are created by the contractor, the contractor shall maintain the classifications, tags, names and *Attributes* in accordance with Appendix D. See Sections 3.10.5 and 3.10.6 on applying and verifying *Equipment* names and *Attributes*.
- The contractor shall add any additional Contact *Attributes* to the *Construction BIMs* as required per Appendix E.

5.10. BIM Methodology

Section 3.11 describes the required BIM methodology for all disciplines and trades creating BIM deliverables.

5.11. BIM Deliverables - Contractor

All BIM deliverables required by the contractor shall be submitted at project closeout.

Contractor - BIM / COBie Deliverables and File Standards

| BIM Deliverable | File Type |
|--------------------|--|
| BIM Execution Plan | .pdf format |
| Construction BIMs | BIMs in .ifc file format / See Section 5.1 |
| COBie Worksheets | COBie format / .xls or .xlsx file type |

Designer - BIM Execution Plan File Naming Convention

| Agent_Deliverable | Character | Project Phase | Character | Building # | Character | File Extension |
|-------------------|-----------|---------------|-----------|------------|-----------|----------------|
| CNTR_BEP | _ | XX | _ | ##### | . | pdf |

Example: CNTR_BEP_CD_19000061.pdf

Contractor - BIM Deliverable File Naming Convention

| Discipline Abbreviation | Character | BIM Type | Character | Building # | Character | File Extension |
|-------------------------|-----------|----------|-----------|------------|-----------|----------------|
| XXXX | _ | CBIM | _ | ##### | . | .ifc and .dwg |

5.11. BIM Deliverables – Contractor (Continued)

Example Name: *ELEC_CBIM_19000061.ifc*

NOTE: See Section 5.1 for a list of discipline and trade abbreviations to use in the *Construction BIM* file name.

Contractor - COBie Worksheet File Naming Convention

| Document Type | Character | Project Title | Character | Building # | Character | File Extension |
|---------------|-----------|---------------|-----------|------------|-----------|----------------|
| COBie | _ | XXXXXXXXXX | _ | ##### | . | .xls or .xlsx |

Example Name: *COBie_TN State Museum_19000061.xls*

5.11.1. Deliverables: BEP

The *BEP* shall be updated and submitted to the owner for review at project phases in accordance with these BIM Standards. The final *BEP* shall be delivered at project closeout.

5.11.2. Deliverables: Construction BIMs

- Submit to the owner, the updated, coordinated *Construction BIMs* for at least the disciplines required by Section 5.1 of these BIM Standards.
 - Updated, coordinated Construction BIMs reflect changes to the building that include but are not limited to addenda, architect’s supplemental instructions, change orders, construction and change directives as formally modified throughout the construction process.
- Submit a complete, validated *Asset Inventory* in *COBie* format.
 - *Construction BIMs* shall include the Type/Component (*Equipment*) names, *Attributes* and values applied to the *BIM Object* properties by the contractor, subcontractors and/or other trades per Appendices D and E.
 - *Construction BIMs* shall include the *Contact Attributes* and values applied to the BIM object properties by the contractor, subcontractors and/or other trades per Appendix E.
 - Site and landscape models shall be provided with any custom (ARX) objects converted to native AutoCAD objects.

5.11.3. Deliverables: COBie Worksheets

- Submit a complete, validated *Asset Inventory* in COBie format.
 - The *Space Inventory* and *Equipment Inventory* shall be published from the *Construction BIMs* into the COBie format for delivery to the owner. See Appendix E for information regarding COBie worksheet formatting and naming conventions.
 - The contractor shall use the *TN OSA COBie Validator* to check that the *Space Inventory* and *Equipment Inventory* in the COBie Worksheets are complete, error-free and in accordance these BIM Standards before submitting to the owner.

6. The BIM Process for Contractors

The following description includes the recommended process for the development of and the management of BIMs by contractors.

1. As early as feasible after project award, the contractor assigns a BIM Manager and documents this in the *BEP*.
2. Each subcontractor or vendor with BIM and/or *COBie* responsibility assigns a BIM Coordinator and documents this in the *BEP*.
3. The BIM Manager works with the BIM Coordinators to review the software to be used and verify that the software meets the requirements of these BIM Standards.
4. The BIM Manager reviews their company's modeling standards to align them with owner requirements and deliverables.
5. The contractor selects file sharing system(s).
6. Contractor develops the *BEP*. This plan is updated throughout the project and submitted for review at the milestones indicated in these BIM Standards.
7. Contractor conducts a BIM kickoff meeting.
8. Contractor sets up the secure, web-based file sharing system(s).
9. The construction team develops the *Construction BIMs*.
10. Prior to fabrication and installation, the construction team identifies and resolves spatial conflicts between building systems and products.
11. During construction, the construction team:
 - a. Fabricates and builds from the coordinated *Construction BIMs*.
 - b. Updates the coordinated *Construction BIMs*. See Section 5.11.2.
 - c. Extracts all coordination drawings from the coordinated *Construction BIMs*.
 - d. Uses the coordinated *Construction BIMs* as the basis for generating any shop drawings.
 - e. Updates and maintains the *Asset* inventories in *COBie* format.
 - i. Captures *Asset Attributes* during product data submittals.
 - ii. Performs preliminary *COBie* validation tests to identify an effective software, data and methodology workflow.
12. At project closeout,
 - a. Submit to the owner, the final *Construction BIMs* organized by discipline and floor in IFC format. Certain BIMs, as identified in Section 5.1, may be delivered in 3D dwg format with no custom objects.
 - b. Review the information provided in the *COBie* document worksheets for conformance to the *Contract Documents*.
 - c. Provide to the owner, the final, complete and validated *Asset Inventory* in *COBie* format.

References

buildingSMART (2013). "Coordination View Version 2.0" <http://www.buildingsmart-tech.org/specifications/ifc-view-definition/coordination-view-v2.0>

East, B. and Carrasquillo-Mangual, M. (2012). "The COBie Guide" https://www.nibs.org/page/bsa_cobieguide

East, B. and Chipman, T. (2011). "Facilities Management Handover." http://buildingsmartalliance.org/docs/BSADOC_COBIE/index.htm

(FEMA) Federal Emergency Management Agency (2012). "Lowest Floor." https://www.fema.gov/media-library-data/1478090503191-375956f5cfdca82b6344181cf19541c8/07_lowest_floor_guide_508_oct2016.pdf

OCCS Development Committee Secretariat (2012). "OmniClass Table 13 – Spaces by Function" Release Date: 2012-05-16 <http://www.omniclass.org>

(NCES) U.S. Department of Education, National Center for Education Statistics. (2006). *Postsecondary Education Facilities Inventory and Classification Manual (FICM)*, 2006 Edition (NCES 2006-160). U.S. Department of Education. Washington, DC.

(NIBS) National Institute of Building Sciences "Chapter 4.4 Design to Building Energy Analysis" National BIM Standard- United States Version 2. http://www.nationalbimstandard.org/nbims-us-v2/pdf/NBIMS-US2_c4.4.pdf

Appendices

Appendix A – BIM Execution Plan Outline - Designers

The following outline indicates the minimum information to be included in a BEP on State of Tennessee projects. Additional information may be included in the BEP as deemed appropriate by the owner, designer and contractor or as otherwise required by these BIM Standards.

Project Information

- Identify project name, SBC number, location (address & geo-reference)
- Identify owner
- Identify effective date or revision date of plan

Project Designer and Designer’s Consultants Information

- Designer firm
 - Discipline
 - Firm name
 - Firm address
 - BIM Manager name
 - BIM Manager contact information
- All Consultants
 - Firm name
 - Firm address
 - BIM coordinator name
 - BIM coordinator contact information

BIM Goals and Objectives

- List owner’s intended goals or end uses of the model
- List the Designer’s and the Designer’s Consultants use of the models during the project

Roles and Responsibilities

- Briefly describe each organization’s responsibility for:
 - Model creation
 - Model quality
 - Model analysis
 - Model management
- Describe the roles of the BIM manager and BIM coordinators

Collaboration Plan

- Describe the collaboration and file sharing system(s) you will use to exchange, merge and visualize models
- Describe the schedule and format of model updates, COBie data updates, and interference checks
- Describe tools and process to be used for interference checking
- Describe the process for executing BIM-based model coordination and clash detection
- Describe process to be used to generate drawings from coordinated models
- Identify owner-accessible files, milestones and read/write privileges

Software for Model Authoring

- Identify all software products to be used for model creation and the software version

Planned Models

- Identify model name and phase of delivery
- Detail contents of each model by phase – components and properties
- Identify authoring company
- Identify authoring tool(s)
- Identify analysis tools to be used and their modeling
- Identify file formats required

Modeling Standards

- Common coordinate system
 - Units
 - File origin (X,Y,Z)
 - Geolocation
- Model partitions
- Naming
 - Files
 - Building level designators
 - Building area designators
 - Discipline designators
 - Layers (if applicable)
 - Properties required for:
 - Owner-requested analyses
 - Designer and the Designer's Consultants-initiated analyses
 - Units and values for properties (e.g. - cubic feet per minute, space use codes from The Postsecondary Education Facilities Inventory and Classification Manual (FICM))
- Level of precision and dimensioning
- Any exclusions from models

Model Analysis Plan

- For each project phase, define:
 - Each analysis that will be performed
 - Software to be used
 - Model(s) to be analyzed
 - File format required
 - Responsible team member(s) for
 - Performing the analysis
 - Producing the analysis model(s)
 - Clash detection
 - Software to be used
 - Model(s) to be analyzed
 - File formats acceptable
 - Any object enablers required
 - Responsible team member(s) for
 - Performing the check
 - Producing the clash detection model(s)
 - Process for resolving clashes

Project Deliverables

- Identify electronic models, drawings, renderings, analyses and reports to be delivered
- Identify all types and attributes to be included in the Design BIMs for Contractor's final COBie deliverables
- Describe process to be used to extract all deliverables from coordinated models
- Describe quality assurance and quality control measures to be implemented
- For Design-Assist projects only, address model sharing and the transition of model responsibilities to the Design-Assist contractor

Sign-Off

- Authorized signature from the Designer and the Designer's Consultants indicating agreement to comply with this *BEP*.

Appendix B – Tips for Preparing a BIM for Export for Energy Analysis

The following are general tips on preparing a BIM for export for use in external energy analysis software programs. gbXML and IFC are two formats currently supported for energy analysis. Refer to your particular BIM software application's help or resource manual for "how-to" information related to these tips.

- Only include in the data exported for energy analysis the building elements necessary for energy analysis. This includes exterior walls, windows, doors, floors, ceilings, roofs, and volumetric heating and cooling zones. Make sure these elements are defined accurately: for example, do not use generic exterior walls for the analysis; the anticipated exterior wall construction should be used instead.
- Area calculations for zones should be set to calculate both area *AND* volume.
- All zones should be contained by bounding elements (wall, floor, ceiling, or roof). One hundred percent of the building volume should be contained within identified zones. Define the sliver space tolerance (if this option is available).
- Overall, keep the geometry of the energy model simple. A complex model may produce errors and will not yield a more accurate analysis.

Related Reference Documents

The following list of documents and/or websites provide additional information on best practices, tips, and data requirements for preparing BIMs for energy analysis.

- GSA BIM Guide: 05 - BIM Guide for Energy Performance Version 2.1 – June 2015
<http://www.gsa.gov/bim>
- ERDC-CERL TR-11-41 Early Design Energy Analysis Using Building Information Modeling Technology:
<https://apps.dtic.mil/dtic/tr/fulltext/u2/a552789.pdf>
- IFC MVD Definition Diagram: Concept Design to Building Energy Analysis (BEA) – Exchange Requirements Model diagram
http://www.blis-project.org/IAI-MVD/Snapshots/GSA-003_ERM_%28BEA%29_Design_to_BuildingEnergyAnalysis.pdf
- Mastering Autodesk Revit Architecture 2018 – Autodesk Authorized Publisher

Appendix C – State of Tennessee Office of the State Architect (TN OSA) Space Naming and Attribute Standards

The table below lists the required *Attributes* of a *Space Inventory* and maps these *Attributes* to their appropriate locations in a *COBie* file. BIM-authoring software may provide *Attributes* that map to these *COBie* locations. If so, the built-in *Attributes* can be used; otherwise, these *Attributes* will need to be added. Ultimately, it is necessary to ensure this information appears in the correct location in the *COBie* file.

GENERAL ATTRIBUTES and COBie WORKSHEET LOCATION

| Placement Requirement | Attribute | Sheet | Column | Comments |
|-----------------------|--------------------------|----------|---------------|---|
| Once Per Project | Building Name | Facility | Name | Owner's Building Number |
| Once Per Project | Facility Identification | Facility | ProjectName | Project Title |
| Once Per Project | Region Code | Facility | SiteName | Optional. May be used to indicate campus or office complex |
| Each Floor | Floor Identification | Floor | Name | Floor Level |
| Each Space | Room Designator 1 | Space | Name | Owner's Space naming standard. See below for format. |
| Each Space | FICM Use Code | Space | Category | For UT and TBR projects only. (See Note 1.) |
| Each Space | OmniClass Table 13 Code | Space | Category | STREAM only. (See Note 2.) |
| Each Space | Unique Space ID | Space | ExtIdentifier | Unique ID that should be generated by BIM-authoring software. |
| Each Space | Net Assignable Area (sf) | Space | NetArea | In SF (For UT and TBR, see FICM) |

Floor Name Format

The floor name shall be provided per the owner's requirements as indicated in the designer's contract drawings. See Appendix E, Table E2, Floor Name and Description.

Space Name Format

The *Space* name shall be the room number of that *Space*. For example, Room 1223 shall have a *Space* Name of 1223.

Zones

The use of the zones on the project, and therefore the Zone worksheet, is at the discretion of the State of Tennessee Project Manager, in conjunction with the *Project Team*, and based on the project's scope. Additional guidance on the *COBie Worksheets* can be found in *The COBie Guide*⁸.

⁸ East and Carrasquillo-Mangual, 2012

Space Category

For Higher Education projects, the *Space* category shall be entered a FICM Use Code. See listing of FICM Use Codes in Appendix C.

For space classification of higher education projects, reference the U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, Postsecondary Education Facilities Inventory and Classification Manual ⁹.

For State of Tennessee Real Estate Asset Management Division (STREAM) projects, space classification is based on OmniClass Table 13 - Spaces by Function ¹⁰. OmniClass Table 13 provides high-level categories for spatial functions as well as the ability to provide very detailed functional classification by adding additional digits. For example, 13-11 21 00 is the classification for Meeting Spaces. Optionally, these can be further broken down:

- a. 13-11 21 11 Meeting Room
- b. 13-11 21 17 Conference Room
- c. 13-11 21 27 Community Room
- d. 13-11 21 41 Interview Room

⁹ (NCES) U.S. Department of Education, National Center for Education Statistics, 2006

¹⁰ (OCCS)OCCS Development Committee Secretariat, 2012

| FICM USE CODES | |
|--|--|
| 100 Classroom Facilities | 110 Classroom Facilities |
| 115 Classroom Service | 200 Laboratories |
| 210 Class Laboratory | 215 Class Laboratory Service |
| 220 Open Laboratory | 225 Open Laboratory Service |
| 250 Research/non-class Laboratory | 255 Research/non-class Laboratory Service |
| 300 Office Facilities | 310 Office |
| 315 Office Service | 350 Conference Room |
| 355 Conference Room Service | 400 Study Facilities |
| 410 Study Room | 420 Stack |
| 430 Open-Stack Study Room | 440 Processing Room |
| 455 Study Service | 500 Special Use Facilities |
| 510 Armory | 515 Armory Service |
| 520 Athletic or Physical Education | 523 Athletic Facilities Spectator Seating |
| 525 Athletic or Physical Education Service | 530 Media Production |
| 535 Media Production Service | 540 Clinic |
| 545 Clinic Service | 550 Demonstration |
| 555 Demonstration Service | 560 Field Building |
| 570 Animal Facilities | 575 Animal Facilities Service |
| 580 Greenhouse | 585 Greenhouse Service |
| 590 Other (All Purpose) | 600 General Use Facilities |
| 610 Assembly | 615 Assembly Service |
| 620 Exhibition | 625 Exhibition Service |
| 630 Food Facility | 635 Food Facility Service |
| 640 Day Care | 645 Day Care Service |
| 650 Lounge | 655 Lounge Service |
| 660 Merchandising | 665 Merchandising Service |
| 670 Recreation | 675 Recreation Service |
| 680 Meeting Room | 685 Meeting Room Service |
| 700 Support Facilities | 710 Central Computer or Telecommunications |
| 715 Central Computer or Telecommunications Service | 720 Shop |
| 725 Shop Service | 730 Central Storage |
| 735 Central Storage Service | 740 Vehicle Storage |
| 745 Vehicle Storage Service | 750 Central Service |
| 755 Central Service Support | 760 Hazardous Materials Storage |
| 770 Hazardous Waste Storage | 775 Hazardous Waste Service |
| 780 Unit Storage | 800 Health Care Facilities |
| 810 Patient Bedroom | 815 Patient Bedroom Service |
| 820 Patient Bath | 830 Nurse Station |
| 835 Nurse Station Service | 840 Surgery |
| 845 Surgery Service | 850 Treatment/Examination Clinic |
| 855 Treatment/Examination Clinic Service | 860 Diagnostic Service Laboratory |

| FICM USE CODES | |
|---|--|
| 865 Diagnostic Service Laboratory Support | 870 Central Supplies |
| 880 Public Waiting | 890 Staff On-Call Facility |
| 895 Staff On-Call Facility Service | 900 Residential Facilities |
| 910 Sleep/Study Without Toilet or Bath | 919 Toilet or Bath |
| 920 Sleep/Study With Toilet or Bath | 935 Sleep/Study Service |
| 950 Apartment | 955 Apartment Service |
| 970 House | 000 Unclassified Facilities |
| 050 Inactive Area | 060 Alteration or Conversion Area |
| 070 Unfinished Area | WWW Circulation Area |
| W01 Bridge/Tunnel | W02 Elevator |
| W03 Escalator | W04 Loading Dock |
| W05 Lobby | W06 Public Corridor |
| W07 Stairway | XXX Building Service Area |
| X01 Custodial Supply Closet | X02 Janitor Room |
| X03 Public Rest Room | X04 Trash Room |
| YYY Mechanical Area | Y01 Central Utility Plant |
| Y02 Fuel Room | Y03 Shaft |
| Y04 Utility/Mechanical Space | AAA01 Arenas - Open Air |
| AAA02 Baseball Fields | AAA03 Basketball Courts |
| AAA04 Bleachers | AAA05 Circuit Training Courses |
| AAA06 Climbing Walls | AAA07 Dugouts |
| AAA08 Field Light Poles | AAA09 Grass Playing Fields |
| AAA10 Hard Playing Surfaces | AAA11 Press Boxes |
| AAA12 Rope Course Elements | AAA13 Running Tracks |
| AAA14 Scoreboards | AAA15 Shooting Ranges |
| AAA16 Ski Lifts | AAA17 Softball Fields |
| AAA18 Stadiums | AAA19 Swimming Pools – Open Air |
| AAA20 Synthetic Fields | AAA21 Tennis Courts |
| AAA22 Volleyball Courts | AAA23 Other Miscellaneous and Not Defined Athletic – Outdoor |

For STREAM projects, the Space category shall be entered as an OmniClass Table 13 code. See listing of OmniClass Table 13 codes in Appendix C.

| OmniClass Table 13 | |
|---|---|
| 13-11 00 00 Space Planning Types | 13-11 11 00 Planned Work Space |
| 13-11 13 00 Planned Building Service Space | 13-11 15 00 Planned Amenity/Support Space |
| 13-11 17 00 Planned Circulation Space | 13-11 19 00 Planned Parking Space |
| 13-13 00 00 Void Areas | 13-13 11 00 Light Well |
| 13-13 13 00 Air Shaft | 13-13 15 00 Occupant Void Area |
| 13-15 00 00 Wall Spaces | 13-15 11 00 Exterior Wall Space |
| 13-15 13 00 Interior Wall Space | 13-17 00 00 Encroachment Spaces |
| 13-17 11 00 Interior Encroachment | 13-17 13 00 Perimeter Encroachment |
| 13-21 00 00 Parking Spaces | 13-21 11 00 Exterior Parking Spaces |
| 13-21 13 00 Interior Parking Spaces | 13-23 00 00 Facility Service Spaces |
| 13-23 11 00 Vertical Penetration | 13-23 12 00 Horizontal Infrastructure/Service Space, Non-Occupied |
| 13-23 13 00 Control Room | 13-23 15 00 Loading Dock |
| 13-23 17 00 Restroom | 13-23 19 00 Utility Equipment Room |
| 13-23 21 00 Waste and Recycling Spaces | 13-23 23 00 Building Service Support Spaces |
| 13-23 25 00 Equipment Platform | 13-23 27 00 Interstitial Space |
| 13-23 29 00 Unimproved Shell | 13-23 31 00 Alteration or Conversion Space |
| 13-25 00 00 Circulation Spaces | 13-25 11 00 Primary Circulation Spaces |
| 13-25 13 00 Transitional Circulation Spaces | 13-25 15 00 Connector |
| 13-25 17 00 External Circulation Spaces | 13-25 19 00 Secondary Circulation Spaces |
| 13-25 21 00 Restricted Spaces | 13-25 23 00 Refuge Spaces |
| 13-31 00 00 Education and Training Spaces | 13-31 11 00 Breakout Space |
| 13-31 13 00 Lecture and Classroom Spaces | 13-31 15 00 Class Laboratories |
| 13-31 17 00 Training Spaces | 13-31 19 00 Study Spaces |
| 13-33 00 00 Recreation Spaces | 13-33 11 00 Athletic Recreation Spaces |
| 13-33 13 00 Swimming Pools | 13-33 15 00 Non-Athletic Recreation Spaces |
| 13-33 17 00 Wellness Spaces | 13-35 00 00 Government Spaces |
| 13-35 11 00 Judicial Spaces | 13-35 13 00 Legislative Spaces |
| 13-35 15 00 Military Spaces | 13-37 00 00 Artistic Spaces |
| 13-37 11 00 Performance Spaces | 13-37 13 00 Display Spaces |
| 13-37 15 00 Creative Spaces | 13-41 00 00 Museum Spaces |

| OmniClass Table 13 | |
|---|--|
| 13-41 11 00 Museum Gallery | 13-45 00 00 Library Spaces |
| 13-45 11 00 Library | 13-47 00 00 Spiritual Spaces |
| 13-47 11 00 Worship spaces | 13-47 13 00 Ceremonial Spaces |
| 13-47 15 00 Procession Spaces | 13-47 17 00 Death Spaces |
| 13-49 00 00 Environmentally Controlled Spaces | 13-49 11 00 Anechoic Chamber |
| 13-49 13 00 Hazard Containment | 13-49 15 00 Clean Room |
| 13-49 17 00 Temperature and Pressure Chamber | 13-49 19 00 Data Center |
| 13-49 21 00 Controlled Space Support | 13-49 23 00 Miscellaneous Environmentally Controlled Spaces |
| 13-51 00 00 Healthcare Spaces | 13-51 11 00 General Examination Spaces |
| 13-51 14 00 Inpatient Care Spaces | 13-51 17 00 Multi-Medical Service Support Spaces |
| 13-51 21 00 Diagnostic Imaging Spaces | 13-51 24 00 Diagnostic Imaging Support Spaces |
| 13-51 27 00 Radiation Diagnostic and Therapy Spaces | 13-51 31 00 Heart and Lung Diagnostic and Treatment Spaces |
| 13-51 34 00 General Diagnostic Procedure and Treatment Spaces | 13-51 37 00 Eye and Ear Healthcare Spaces |
| 13-51 41 00 Endoscopy/Gastroenterology Spaces | 13-51 44 00 Surgical Spaces |
| 13-51 47 00 Clinical Laboratory Spaces | 13-51 51 00 Clinical Laboratory Support Spaces |
| 13-51 54 00 Pharmacy Spaces | 13-51 57 00 Medical Services Logistic Spaces |
| 13-51 61 00 Rehabilitation Spaces | 13-51 64 00 Dental Spaces |
| 13-51 67 00 Medical Research and Development Spaces | 13-53 00 00 Laboratory Spaces |
| 13-53 11 00 Chemistry Laboratories | 13-53 13 00 Biosciences Laboratories |
| 13-53 15 00 Physical Sciences Laboratories | 13-53 17 00 Astronomy Laboratories |
| 13-53 19 00 Earth and Environmental Sciences Laboratories | 13-53 21 00 Forensics Laboratories |
| 13-53 23 00 Psychology Laboratories | 13-53 25 00 Bench Laboratories |
| 13-53 27 00 Dry Laboratories | 13-53 29 00 Integration Laboratories |
| 13-53 31 00 Wet Laboratories | 13-53 33 00 Laboratory Storage Spaces |
| 13-53 35 00 Laboratory Support Spaces | 13-55 00 00 Commerce Activity Spaces |
| 13-55 11 00 Office Spaces | 13-55 13 00 Banking Spaces |
| 13-55 15 00 Trading Spaces | 13-55 17 00 Demonstration Spaces |
| 13-55 19 00 Sales Spaces | 13-55 21 00 Commercial Service and Repair Spaces |
| 13-55 23 00 Commercial Support Spaces | 13-55 27 00 Hotel, Motel, Hostel, and Dormitory Service Spaces |
| 13-55 29 00 Commerce Activity Support Areas | 13-57 00 00 Service Activity Spaces |

| OmniClass Table 13 | |
|---|---|
| 13-57 11 00 Grooming Activity Spaces | 13-57 13 00 Food Service |
| 13-57 15 00 Child Care Spaces | 13-57 17 00 Resting Spaces |
| 13-57 21 00 Laundry/Dry Cleaning Space | 13-57 23 00 Smoking Space |
| 13-59 00 00 Production, Fabrication, and Maintenance Spaces | 13-59 11 00 Material Handling Area |
| 13-59 13 00 Batching Space | 13-59 15 00 Production Process |
| 13-59 17 00 Printing and Reproduction Spaces | 13-59 19 00 Quality Control and Test Spaces |
| 13-59 21 00 Production Service and Repair Spaces | 13-59 23 00 Production and In-Process Storage Spaces |
| 13-59 25 00 Production Support Spaces | 13-59 29 00 Greenhouse Spaces |
| 13-61 00 00 Protective Spaces | 13-61 11 00 Animal Securing Spaces |
| 13-61 13 00 Detention Spaces | 13-61 15 00 Spaces for Protection from the Elements |
| 13-61 17 00 Spaces for Protection from Violence | 13-63 00 00 Storage Spaces |
| 13-63 11 00 Warehouse Spaces | 13-63 13 00 Non-Warehouse Storage Spaces |
| 13-63 15 00 Moveable Storage Spaces | 13-63 17 00 Environmentally Controlled Storage Spaces |
| 13-63 19 00 Specialty Storage Spaces | 13-65 00 00 Private Residential Spaces |
| 13-65 11 00 On-call Room | 13-65 13 00 Bathroom |
| 13-65 15 00 Mud Room | 13-65 17 00 Laundry Room |
| 13-65 19 00 Bedroom | 13-65 21 00 Nursery |
| 13-65 23 00 Kitchen | 13-67 00 00 Alternate Workplace |
| 13-67 11 00 Customer Site | 13-67 13 00 Home Office |
| 13-67 15 00 Rent-An-Office | 13-67 17 00 No Fixed Location |
| 13-67 19 00 Supplier Site | 13-69 00 00 Building Associated Spaces |
| 13-69 11 00 Roof | 13-69 13 00 Roof Terrace |
| 13-69 15 00 Penthouse | 13-69 17 00 Antenna Farm |
| 13-69 19 00 Heliport | 13-69 21 00 Balcony |
| 13-69 23 00 Deck | 13-69 25 00 Pedestrian Travel Spaces |

Appendix D – State of Tennessee Office of the State Architect (TN OSA) Asset Naming and Attribute Requirements

Asset Types

Equipment is defined by Types, with each Type representing a single manufacturer and model number. Each Type must be unique. Every piece of *Equipment* is of one Type. All pieces of *Equipment* of the same Type must have the same:

- Manufacturer
- ModelNumber
- Category
- AssetType
- WarrantyGuarantorParts
- WarrantyDurationParts
- WarrantyDurationUnit
- All other *Attributes* designated as “TYPE” (Tables D1, D2 and E1). All Type names must follow the type naming format.

Type Naming Standard Format

Building # - Type ID Type Count

Building #: The building number, See Section 3.4.

Type ID: Abbreviation found in Column 4 of Table D2 and used to identify the kind of *Equipment*.

Type Count: The number used to distinguish different products of the same Type ID. For example, air handling units (AHU) from different manufacturers.

Example: All air handling units from manufacturer X with model number Y in building 1900006 would be Type:

1900006-AHU1

All air handling units from manufacturer A with model number B in building 1900006 would be Type:

1900006-AHU2

See the *Tables D1 and D2* for a full listing of suggested Type IDs and required *Attributes*.

Components

Each physical instance of a Type within a project is considered a Component. For example, the same roof top unit may recur many times. In this case, each individual roof top unit is a Component. The values of “COMPONENT” *Attributes* may vary between Components of the same Type. Each component must have a unique name.

Component Naming Standard Format

Equipment Category-Type Name-Floor Name-Sequence #

Equipment Category: This is the abbreviation for the *Equipment* category. See Table D2. This table identifies 7 *Equipment* categories: HVAC, PLBG, ELEC, FSUP, CNVSY, ARCH and SITE.

Type Name: This is the name of the Type. See Appendix C, *Type Naming Standard Format*.

Floor: The owner’s required floor name as provided by the designer in the contract drawings. See Appendix C, *Floor Name Format*.

Sequence #: A unique, preferably sequential number for each Component of a Type on the identified floor

Example: The first instance of Type 1900006-AHU1 on the 12th floor would be Component:

HVAC-1900006-AHU1-12-1

NOTE: Although it is desirable that Component Sequence Numbers to be consecutive, designers and/or contractors are **not** required to renumber Components when there are changes. Contractors shall maintain designer’s numbering for all Components that were included in the *Design BIM* in accordance with these BIM Standards. Added Components shall continue the existing sequence.

Component Tag Standard Format

When tagging Components on the contract drawings, an abbreviated version of the Component name is used.

Type ID Type Count – Sequence #

A component named HVAC-1900006-AHU1-12-1 would be tagged in the contract drawings as:

AHU1-1

Component Tag Standard Format (Continued)

NOTE: The component tag shall be mapped or otherwise populated into the component’s Description field. See Appendix E, Table E2, Component (Column 1) and Description (Column 3).

Equipment Inventory

The *Equipment Attributes* that are required in the *Equipment Inventory* are categorized as Group A, Group B and Group C. The *Attributes* required by Group A and Group B are indicated in Table D1.

For Group C *Attributes*, see Table D2, Column 6. In Table D1, the *Equipment Type Attribute* named **Category** shall be provided as an OmniClass Number from Table D2 column 3. Table D2 maps the Type Description in column 1 to the corresponding Table 23 OmniClass Number in column 3.

The Equipment Type Attribute named **Category** shall include the Table 23 OmniClass Number followed by the OmniClass Title. As an example, the Type Attribute named **Category** for a chiller would be: **23.33.21.00: Chiller**.

* The Type Attribute in Group A named Category, shall be entered as the Table 23 OmniClass Number provided in Table D2 Column 3.

**The values that can be used for the “SpatialPlacement” attribute shall include, but not be limited to AboveCeiling, InSpace, InWall, OnRoof, OnSite, or UnderFloor.

***All Group C Attributes indicated in column 6 of Table D2 are Type Attributes unless denoted by (CA) indicating the attribute is a Component Attribute.

****See Appendix E, Table E2 for information relating to the Type Description and the Component Description.

TABLE D1 - STATE OF TENNESSEE - EQUIPMENT ATTRIBUTE GROUPS

| ATTRIBUTE GROUP | ATTRIBUTE | TYPE/COMPONENT ATTRIBUTE |
|-----------------|----------------------------|--------------------------|
| A | Name | Type/Component |
| A | CreatedBy | Type/Component |
| A | CreatedOn | Type/Component |
| A | Description**** | Type/Component |
| A | Category* | Type |
| A | AssetType | Type |
| A | WarrantyGuarantorParts | Type |
| A | WarrantyDurationParts | Type |
| A | WarrantyDurationUnit | Type |
| A | Manufacturer | Type |
| A | ModelNumber | Type |
| A | SpecificationSection | Type |
| A | TagNumber | Component |
| A | SerialNumber | Component |
| A | InstallationDate | Component |
| A | Space | Component |
| A | SpatialPlacement ** | Component |
| A | WarrantyStartDate | Component |
| B | Current | Type |
| B | Voltage | Type |
| C | See Table D2, Column 6**** | See Table D2, Column 6** |

Equipment Naming Standards and Attributes

Table D2 includes the minimum equipment types and *Attributes* required by these BIM Standards. Additional equipment and attributes may be required by the owner or SPA. The extent of equipment and attributes to be included in the project scope should be coordinated at the start of the project and documented in the *BEP and in the TNNamingSystem spreadsheet*.

While the Type ID indicated in Table D2, Column 4 is recommended, designers may use their own Type ID naming system. When an alternative Type ID naming system is implemented, it shall be documented in the *TNNamingSystem spreadsheet* provided on the TN OSA website. This spreadsheet shall be imported into the *TN OSA COBie Validator* and the *Design BIMs* shall be validated prior to hand off to the contractor. If the Type ID naming system provided in table D2 is implemented by the designer, the *TNNamingSystem spreadsheet* does **not** have to be imported into the default *TN OSA COBie Validator*. The OSA website provides guidance on how to import the *TNNamingSystem spreadsheet* into the *TN OSA COBie Validator*.

It is the responsibility of the designer to apply and maintain the *Attribute* parameters for all required *Attributes* in their *Design BIM*. See Section 3.10.6 and Appendix E, Table E1. It is the responsibility of the contractor to apply and maintain the *Attribute* parameters for all required *Attributes* in their *Construction BIMs*. See Section 5.9.1.5 and Appendix E, Table E1. CADD Microsystems has developed a *TN-Specific Rule Set Model Checker*. The rule set checks that all required *TN Attributes* have been applied as Revit parameters, based on the Type ID. If a designer or contractor wants to run these checks, a type parameter called *TNID* needs to be included on all *COBie Equipment* in the Revit model. The value of the *TNID* parameter is the same as the Type ID for that kind of *Equipment*. NOTE: For equipment not listed in Table D2, refer to the most current OmniClass Table 23 for the OmniClass Title and OmniClass Number.

TABLE D2 – TN - STANDARD REQUIRED EQUIPMENT - ASSET MAPPING AND ATTRIBUTES

| 1 ASSET DESCRIPTION | 2 OmniClass TITLE | 3 TABLE 23 OmniClass # | 4 TYPE ID | 5 ATTRIBUTE GROUP (See Table D1) | 6 GROUP C ATTRIBUTES * | 7 EQUIPMENT CATEGORY |
|---------------------------------|------------------------------|------------------------|-----------|----------------------------------|--|----------------------|
| CHILLERS | Chillers | 23.33.21.00 | CH | A, B | Power, Capacity, ChillerType, RefrigerantType, VariableSpeedDrive | HVAC |
| BOILERS | Commercial Boilers | 23.33.11.00 | BLR | A, B | FullLoadFuelConsumption, ThermalEfficiency, FuelType | HVAC |
| AIR HANDLING UNITS | Air Handling Units | 23.33.25.00 | AHU | A, B | CoilFlow, CoilCapacity, HeatingCoilType | HVAC |
| FAN COIL UNITS | HVAC Fan Coil Units | 23.33.33.00 | FCU | A, B | TotalCapacity, CoolingCoilDeltaP, FanMotorHorsepower, Phase, HeatingCoilType | HVAC |
| EVAPORATOR UNITS (INDOOR UNITS) | Refrigerant Condensing Units | 23.33.37.00 | EU | A, B | FanMotorHorsepower, Phase, CoilType, ExpansionDevice | HVAC |
| FANS | Air Circulators | 23.33.31.00 | FAN | A, B | FanMotorHorsepower | HVAC |
| AIR TERMINAL UNITS | HVAC Air Terminals | 23.33.41.00 | ATU | A, B | AirFlow-Minimum, HeatType | HVAC |
| HEAT PUMPS (PACKAGED/SPLIT) | Heat Pumps | 23.33.17.00 | HP | A, B | Capacity, RefrigerantType | HVAC |
| CONDENSER UNITS (OUTDOOR UNITS) | HVAC Condenser Units | 23.33.43.00 | CU | A, B | Cooling Capacity, RefrigerantType | HVAC |

TABLE D2 – TN - STANDARD REQUIRED EQUIPMENT - ASSET MAPPING AND ATTRIBUTES

| 1 ASSET DESCRIPTION | 2 OmniClass TITLE | 3 TABLE 23 OmniClass # | 4 TYPE ID | 5 ATTRIBUTE GROUP (See Table D1) | 6 GROUP C ATTRIBUTES * | 7 EQUIPMENT CATEGORY |
|--------------------------------------|--------------------------------------|------------------------|-----------|----------------------------------|---|----------------------|
| COMPUTER ROOM AIR CONDITIONING UNIT | Air Conditioning Equipment | 23.33 39 00 | CRAC | A, B | Capacity, RefrigerantType, Phase | HVAC |
| COOLING TOWERS | Cooling Towers | 23.33 23 00 | CLGTWR | A, B | Capacity, Power | HVAC |
| HEAT EXCHANGERS | Heat Exchangers | 23.27 23 00 | HX | A, B | CoolingType, PipeType | HVAC |
| COMPRESSORS | Compressors | 23.27 21 00 | COMPR | A, B | Capacity, RefrigerantType, | HVAC |
| PUMPS | Pumps | 23.27.17.00 | HVP | A, B | PumpMotorHorsepower | HVAC |
| ROOFTOP PACKAGED UNITS | HVAC Specific Products and Equipment | 23.33.00.00 | RTU | A, B | Capacity, RefrigerantType | HVAC |
| EXHAUST HOODS (KITCHEN/LAB) | Air Circulators | 23.33.31.00 | EXH | A, B | FanMotorHorsepower, Phase, FanSpeed | HVAC |
| WATER HEATERS | Hot Water Heaters | 23.31 29 00 | WH | A, B | Capacity, FullLoadFuelConsumption, FuelType | PLBG |
| PLUMBING PUMPS | Pumps | 23.27.17.00 | PLP | A, B | | PLBG |
| FIRE SUPPRESSION PUMPS | Pumps | 23.27.17.00 | FSUPP | A, B | | FSUP |
| GENERATORS | Electrical Generators | 23.35.11.00 | GEN | A, B | FuelType, AirPermit | ELEC |
| UNINTERRUPTED POWER SUPPLY | Power Conditioning Equipment | 23.35.23.00 | UPS | A, B | Power | ELEC |
| TRANSFORMERS | Transformers | 23.35.13.00 | XFMR | A, B | Phase, StepType, CoreType, InstrumentType | ELEC |
| ELEVATORS | | 23.23.11.00 | ELEV | A, B | Capacity | CNVSYS |
| CRANES | Materials Handling | 23.23.17.00 | CRANE | A, B | | CNVSYS |
| DOORS** | Doors | 23.17.11.00 | DR | A | FireLabelClass, FireLabelRating | ARCH |
| ELECTRIC METER | Electrical Utility Equipment | 23-39 23 00 | EM | A, B | MeterType | SITE |
| GAS METER | Natural Gas Utility Equipment | 23-39 25 00 | GM | A | MeterType | SITE |
| WATER METER | Water Utility Equipment | 23-39 27 00 | WM | A | MeterType | SITE |
| SITE WATER PUMPS | Pumps | 23.27.17.00 | SWP | A, B | Power | SITE |
| SITE FIRE SUPPRESSION PUMPS | Pumps | 23.27.17.00 | SFSUPP | A, B | Power | SITE |
| WATER SUPPLY WELL PUMPS | Pumps | 23.27.17.00 | WSWP | A, B | Power | SITE |
| SEWER PUMPS | Pumps | 23.27.17.00 | SWRP | A, B | RatedFlow, ControllerType | SITE |
| FUEL DISTRIBUTION PUMPS | Pumps | 23.27.17.00 | FDP | A, B | Service, Power, Phase | SITE |
| FUEL DISTRIBUTION TANKS/CONTAINMENTS | Tanks and Storage Structures | 23.27.29.00 | FDTNK | A | Capacity, FuelType | SITE |

* All Additional Attributes indicated in column 6 of Table D2 are Type Attributes unless denoted by (C) indicating the attribute is a Component Attribute.
 ** All scheduled doors require COBie data including overhead doors, revolving doors, fire-rated doors, and fire shutters.

Appendix E – COBie Documents and Formatting

Table E1 indicates the parameter values that are to be provided in the BIMs by the designer and the contractor. The table indicates the BIMs in which these values are to be provided and also indicates the project stage in which this data should be added and/or updated in the *Design BIMs* or the *Construction BIMs*.

Table E1 - Legend

- D:** *Attribute* value required from designer
- U/D:** *Attribute* value to be updated by designer
- C:** *Attribute* value required from contractor
- U/C:** *Attribute* value to be updated by contractor

The *Equipment Inventory* and all required Type and Component *Attributes* shall be submitted in COBie format. A blank COBie template can be found at:

https://www.nibs.org/page/bsa_cobietemplate.

Table E2 indicates the worksheets found in a COBie workbook that are required by the State of TN. The Zone worksheet is optional.

- Contact
- Facility
- Floor
- Space
- Zone*
- Type
- Component
- System
- Document**
- Attribute

Table E2 lists the TN-required *COBie Worksheets* and the information that shall be provided in each Worksheet for an *Asset Inventory*.

Additional guidance on the *COBie Worksheets* can be found in The *COBie Guide* (East and Carrasquillo-Mangual 2012).

*The use of the zones on the project, and therefore the Zone worksheet, is not required by these BIM Standards. It is at the discretion of the State of Tennessee Project Manager, in conjunction with the *Project Team*, and based on the project's scope.

**While the Document worksheet is required by the contractor as part of the *COBie* documentation, it is not included in Table E1 as this information may not typically be maintained within the BIM model.

TABLE E1 - STATE OF TENNESSEE - DESIGNER AND CONTRACTOR REQUIRED BIM ATTRIBUTE VALUES FOR COBie DOCUMENTATION BY PROJECT STAGE

| COBie WORKSHEET | REQUIRED ATTRIBUTES* | BIM TYPE WHERE ATTRIBUTE VALUES ARE PROVIDED | DD PHASE | CD PHASE | CNTR APPROVED SUBMITTALS | CNTR INSTALLATION |
|-----------------|--|--|----------|----------|--------------------------|-------------------|
| FACILITY | Name | Design BIMs | D | U/D | | |
| FACILITY | CreatedBy | Design BIMs | D | U/D | | |
| FACILITY | CreatedOn | Design BIMs | D | U/D | | |
| FACILITY | Category | Design BIMs | D | U/D | | |
| FACILITY | ProjectName | Design BIMs | D | U/D | | |
| FACILITY | SiteName | Design BIMs | D | U/D | | |
| FACILITY | LinearUnits | Design BIMs | D | U/D | | |
| FACILITY | AreaUnits | Design BIMs | D | U/D | | |
| FACILITY | VolumeUnits | Design BIMs | D | U/D | | |
| FACILITY | CurrencyUnit | Design BIMs | D | U/D | | |
| FACILITY | AreaMeasurement | Design BIMs | D | U/D | | |
| FACILITY | Description | Design BIMs | D | U/D | | |
| FLOOR | Name | Design BIMs | D | U/D | | |
| FLOOR | CreatedBy | Design BIMs | D | U/D | | |
| FLOOR | CreatedOn | Design BIM | D | U/D | | |
| FLOOR | Category | Design BIMs | D | U/D | | |
| FLOOR | Elevation | Design BIMs | D | U/D | | |
| FLOOR | Height | Design BIMs | D | U/D | | |
| SPACE | Name | Design BIMs | D | U/D | | |
| SPACE | CreatedBy | Design BIMs | D | U/D | | |
| SPACE | CreatedOn | Design BIMs | D | U/D | | |
| SPACE | Category | Design BIMs | D | U/D | | |
| SPACE | FloorName | Design BIMs | D | U/D | | |
| SPACE | Description | Design BIMs | D | U/D | | |
| SPACE | GrossArea | Design BIMs | D | U/D | | |
| SPACE | NetArea | Design BIMs | D | U/D | | |
| CONTACT | Email | Design BIMs / Construction BIMs | D | U/D | C | U/C |
| CONTACT | CreatedBy | Design BIMs / Construction BIMs | D | U/D | C | U/C |
| CONTACT | CreatedOn | Design BIMs / Construction BIMs | D | U/D | C | U/C |
| CONTACT | Category | Design BIMs / Construction BIMs | D | U/D | C | U/C |
| CONTACT | Phone | Design BIMs / Construction BIMs | D | U/D | C | U/C |
| CONTACT | Company | Design BIMs / Construction BIMs | D | U/D | C | U/C |
| TYPE / CMPNT ** | Name (Type and Component) | Design BIMs / Construction BIMs | D | U/D | C | U/C |
| TYPE / CMPNT ** | CreatedBy (Type and Component) | Construction BIMs | | | C | U/C |
| TYPE / CMPNT ** | CreatedOn (Type and Component) | Construction BIMs | | | C | U/C |
| TYPE / CMPNT ** | Category (Type) | Construction BIMs | | | C | U/C |
| TYPE / CMPNT ** | Description (Type and Component) | Construction BIMs | | | C | U/C |
| TYPE / CMPNT ** | AssetType (Type) | Construction BIMs | | | C | U/C |
| TYPE / CMPNT ** | Warranty Guarantor Parts (Type) | Construction BIMs | | | C | U/C |
| TYPE / CMPNT ** | Warranty Duration Parts (Type) | Construction BIMs | | | C | U/C |
| TYPE / CMPNT ** | Warranty Duration Unit (Type) | Construction BIMs | | | C | U/C |
| TYPE / CMPNT ** | Manufacturer (Type) | Construction BIMs | | | C | U/C |
| TYPE / CMPNT ** | ModelNumber (Type) | Construction BIMs | | | C | U/C |
| TYPE / CMPNT ** | All Type Attributes from Table D2 Column 6 | Construction BIMs | | | C | U/C |
| TYPE / CMPNT ** | All Component Attributes from Table D2 Column 6 | Construction BIMs | | | | C |
| TYPE / CMPNT ** | TagNumber (Component) | Construction BIMs | | | | C |

TABLE E1 - STATE OF TENNESSEE - DESIGNER AND CONTRACTOR REQUIRED BIM ATTRIBUTE VALUES FOR COBie DOCUMENTATION BY PROJECT STAGE

| | | | | | | |
|-----------------|------------------------------|--------------------|--|--|---|-----|
| TYPE / CMPNT ** | SerialNumber (Component) | Construction BIMs | | | | C |
| TYPE / CMPNT ** | InstallationDate (Component) | Construction BIMs | | | | C |
| TYPE / CMPNT ** | SpatialPlacement | Constructions BIMs | | | | C |
| TYPE / CMPNT ** | SpecificationSection | Construction BIMs | | | | C |
| SYSTEM | Name | Construction BIMs | | | C | U/C |
| SYSTEM | CreatedBy | Construction BIMs | | | C | U/C |
| SYSTEM | CreatedOn | Construction BIMs | | | C | U/C |
| SYSTEM | Category | Construction BIMs | | | C | U/C |
| SYSTEM | ComponentNames | Construction BIMs | | | C | U/C |
| ATTRIBUTE | Name | Construction BIMs | | | C | U/C |
| ATTRIBUTE | CreatedBy | Construction BIMs | | | C | U/C |
| ATTRIBUTE | CreatedOn | Construction BIMs | | | C | U/C |
| ATTRIBUTE | Category | Construction BIMs | | | C | U/C |
| ATTRIBUTE | SheetName | Construction BIMs | | | C | U/C |
| ATTRIBUTE | RowName | Construction BIMs | | | C | U/C |
| ATTRIBUTE | Value | Construction BIMs | | | C | U/C |
| ATTRIBUTE | Unit | Construction BIMs | | | C | U/C |

*See Table E2, Column 3 for Attribute Descriptions

**For all Equipment other than Doors, designers are required to provide the Name Attribute (Type and Component) in the Design BIM. Designers are required to provide all Attributes for Doors. See Tables D1 and D2.

TABLE E2 - STATE OF TENNESSEE - REQUIRED COBie WORKSHEETS AND ATTRIBUTES

| 1 COBie WORKSHEET | 2 WORKSHEET COLUMN (ATTRIBUTE) | 3 DESCRIPTION |
|----------------------|--------------------------------------|--|
| Contact | Email | One row for each discipline or organization that provides COBie information, including manufacturers and guarantors |
| Contact | CreatedBy | Entered as an email that is listed in the Email column on the Contact worksheet |
| Contact | CreatedOn | Date/time entered in ISO 8601 format, YYYY-MM-DDTHH:mm:ss (e.g. 2018-03-18T17:02:59) |
| Contact | Category | Use OmniClass Table 34 Organizational Roles |
| Contact | Company | The name of the company for the Email |
| Contact | Phone | The telephone number for the Email. |
| Facility | Name | The Owner's Building Number (See Sections 3.4 and 5.4) |
| Facility | CreatedBy | Entered as an email which must occur on the Contact worksheet |
| Facility | CreatedOn | Date/time entered in ISO 8601 format, YYYY-MM-DDTHH:mm:ss (e.g. 2018-03-18T17:02:59) |
| Facility | Category | Use OmniClass Table 11 Construction Entities by Function |
| Facility | ProjectName | The Project Title |
| Facility | SiteName | The name of the Site |
| Facility | LinearUnits | The associated linear unit of measurement applied to all COBie information other than that found in the Attribute worksheet |
| Facility | AreaUnits | The associated area unit of measurement applied to all COBie information other than that found in the Attribute worksheet |
| Facility | VolumeUnits | The associated volume unit of measurement applied to all COBie information other than that found in the Attribute worksheet |
| Facility | CurrencyUnit | The associated currency applied to all COBie information other than that found in the Attribute worksheet |
| Facility | AreaMeasurement | The measurement method used to calculate areas. (e.g. BOMA, Standard Revit Area, etc.) |
| Facility | Description | A general description of the facility |
| Floor | Name | One row for each vertical level to include foundations, floors, roofs, and site per the owner's requirements as indicated in the designer's contract drawings. |
| Floor | CreatedBy | Entered as an email which must occur on the Contact worksheet |
| Floor | CreatedOn | Date/time entered in ISO 8601 format, YYYY-MM-DDTHH:mm:ss (e.g. 2018-03-18T17:02:59) |
| Floor | Category | Typical terms are: Floor, Roof, or Site. Value must occur in the FloorType column on the PickLists worksheet. |
| Floor | Elevation | Elevation at the top of the floor structure |
| Floor | Height | Distance between top of floor structure to bottom of structure above |

TABLE CONTINUED ON NEXT PAGE

TABLE E2 - STATE OF TENNESSEE - REQUIRED COBie WORKSHEETS AND ATTRIBUTES

| 1 COBie WORKSHEET | 2 WORKSHEET COLUMN (ATTRIBUTE) | 3 DESCRIPTION |
|----------------------|--------------------------------------|---|
| Space | Name | One row per functional space, per room. Multiple spaces in a room are possible |
| Space | CreatedBy | Entered as an email which must occur on the Contact worksheet |
| Space | CreatedOn | Date/time entered in ISO 8601 format, YYYY-MM-DDTHH:mm:ss (e.g. 2018-03-18T17:02:59) |
| Space | Category | Use FICM or OmniClass Table 13 Spaces by Function. |
| Space | FloorName | Must be a name listed on the Floor worksheet |
| Space | Description | The description of the space |
| Space | GrossArea/Net Area* | The total space area, See Facility > AreaMeasurement for information regarding GrossArea and NetArea measurement standard |
| Zone (Optional)* | Name | The name of the zone, There should be one row for each COBie.Space and COBie.Zone pairing. |
| Zone (Optional)* | CreatedBy | Entered as an email which must occur on the Contact worksheet |
| Zone (Optional)* | CreatedOn | Date/time entered in ISO 8601 format, YYYY-MM-DDTHH:mm:ss (e.g. 2018-03-18T17:02:59) |
| Zone (Optional)* | Category | A classification for the identified Zone. Typical values are: Circulation Zone, Lighting Zone, Fire Alarm Zone, Historical Preservation Zone, Occupancy Zone, or Ventilation Zone. Value must occur in the ZoneType column on the PickLists worksheet |
| Zone (Optional)* | SpaceNames | Entered as a Name that must occur on the Space worksheet |
| Type | Name | One row for each owner required equipment Type. |
| Type | CreatedBy | Entered as an email which must occur on the Contact worksheet |
| Type | CreatedOn | Date/time entered in ISO 8601 format, YYYY-MM-DDTHH:mm:ss (e.g. 2018-03-18T17:02:59) |
| Type | Category | Use OmniClass Table 23 Products (See Table D2, Column 3). |
| Type | Description | A general description of the asset type |
| Type | AssetType | Indicate if Type is “moveable” or “fixed”. |
| Type | Manufacturer | Entered as an email which must occur on the Contact worksheet |
| Type | ModelNumber | The model number of the installed product |
| Type | WarrantyGuarantorParts | Entered as an email which must occur on the Contact worksheet |
| Type | WarrantyDurationParts | The length of the warranty period for replacement parts |
| Type | WarrantyDurationUnit | The unit of measure for the durations listed in WarrantyDurationParts and WarrantyDurationLabor (e.g. year, month, etc.) |

Any additional Type Attributes will be recorded on the Attribute worksheet. For a full list of all the Type Attributes (including these) required for specific equipment Types, see Appendix D.

*The use of the zones on the project, and therefore the Zone worksheet, is at the discretion of the State of Tennessee Project Manager, in conjunction with the Project Team, and based on the project’s scope.

**COBie requirements for Gross Area and Net Area should be determined at the beginning of the project and documented in the BEP.

TABLE CONTINUED ON NEXT PAGE

TABLE E2 - STATE OF TENNESSEE - REQUIRED COBie WORKSHEETS AND ATTRIBUTES

| 1 COBie WORKSHEET | 2 WORKSHEET COLUMN (ATTRIBUTE) | 3 DESCRIPTION |
|--|---|--|
| Component | Name | One row for each individually scheduled product or each instance of tagged equipment |
| Component | CreatedBy | Entered as an email which must occur on the Contact worksheet |
| Component | CreatedOn | Date/time entered in ISO 8601 format, YYYY-MM-DDTHH:mm:ss (e.g. 2018-03-18T17:02:59) |
| Component | TypeName | Must be a Type name listed on the Type worksheet |
| Component | Space | Must be a Space name listed on the Space worksheet |
| Component | Description | This is the abbreviated component name as tagged in the contract drawings. See Appendix C, Component Tag Standard Format. |
| Component | SerialNumber | The serial number of the installed equipment, if applicable |
| Component | InstallationDate | The date the equipment was installed entered in ISO 8601 format, YYYY-MM-DDTHH:mm:ss (e.g. 2018-03-18T17:02:59) |
| Component | WarrantyStartDate | The start date of the equipment's warranty entered in ISO 8601 format, YYYY-MM-DDTHH:mm:ss (e.g. 2018-03-18T17:02:59) |
| Component | TagNumber | The name for the equipment as listed on the equipment's tag |
| Component | Any additional Component Attributes will be recorded on the Attribute worksheet. For a full list of all the Component Attributes (including these) required for specific equipment Types, see Appendix D. | |
| System | Name | The name of the system, There should be one row for each COBie.Component and COBie.System pairing. |
| System | CreatedBy | Entered as an email which must occur on the Contact worksheet |
| System | CreatedOn | Date/time entered in ISO 8601 format, YYYY-MM-DDTHH:mm:ss (e.g. 2018-03-18T17:02:59) |
| System | Category | Use OmniClass Table 21 Elements. |
| System | ComponentNames | Must be a Component name listed on the Component worksheet |
| Document (See Appendix E, Table E3) | Name | One row for each deliverable document related to Types and Components. See Appendix E, Table E3 for the naming convention |
| Document | CreatedBy | Entered as an email which must occur on the Contact worksheet |
| Document | CreatedOn | Date/time entered in ISO 8601 format, YYYY-MM-DDTHH:mm:ss (e.g. 2018-03-18T17:02:59) |
| Document | Category | Applicable values are listed in the Document Type column in the Document Naming Convention Table E3 in Appendix E. Value must occur in the DocumentType column on the PickLists worksheet. |
| Document | ApprovalBy | Allowed values listed in the ApprovalBy column on the PickLists worksheet. Standard values are Owner Approval, Contractor Certified, and Information Only |
| Document | Stage | Allowed values listed in the StageType column on the PickLists worksheet. See COBie template, PickLists worksheet for standard values. |
| Document | SheetName | Documents may be associated with Types, Components, Systems, or other COBie worksheets. Enter the appropriate worksheet for the document. |
| Document | RowName | This value must occur in the Name column on the worksheet listed in the SheetName field. |
| Document | Directory | The full path name to the file, but not including the file name |
| Document | File | The name of the file, as listed in the Name field, with the file extension (e.g. PD-101-AHU0001.PDF) |

TABLE E2 - STATE OF TENNESSEE - REQUIRED COBie WORKSHEETS AND ATTRIBUTES

| 1 COBie WORKSHEET | 2 WORKSHEET COLUMN (ATTRIBUTE) | 3 DESCRIPTION |
|----------------------|--------------------------------------|--|
| Attribute | Name | One row for each required Type or Component Attribute that is not included on another COBie worksheet. See Appendix D |
| Attribute | CreatedBy | Entered as an email which must occur on the Contact worksheet |
| Attribute | CreatedOn | Date/time entered in ISO 8601 format, YYYY-MM-DDTHH:mm:ss (e.g. 2018-03-18T17:02:59) |
| Attribute | Category | Value must occur in the StageType column on the PickLists worksheet |
| Attribute | SheetName | Attributes may be associated with Space, Types, Components, or other COBie worksheets. Enter the appropriate worksheet for the attribute. |
| Attribute | RowName | This value must occur in the Name column on the worksheet listed in the SheetName field. |
| Attribute | Value | This is the Attribute value. For example, a pump's FlowRate may be 30 gallons per minute. The value would be 30. |
| Attribute | Unit | This is the unit of the Attribute value. For example, a pump's FlowRate may be 30 gallons per minute. The unit would be gpm. Some attribute units are provided by the designer and some are provided by the Contractor. See Appendix D |

END OF TABLE

In reference to the *COBie Worksheet* tab titled *Document*, Table E3 identifies the document types related to managed *Assets* that should be listed in the Document Worksheet in the *COBie* deliverable.

TABLE E3 - STATE OF TENNESSEE - COBie DOCUMENT NAMING CONVENTION

| DOCUMENT TYPE | DOCUMENT CODE | DOCUMENT NAMING CONVENTION |
|--|---------------|---|
| Cut Sheet | CS | CS–Type Name |
| Manufacturer Certificates | MC | MC–Type Name |
| Manufacturer Installation Instructions | MII | MII–Type Name |
| Material Safety Data Sheet | MSDS | MSDS–Type Name |
| Manufacturer Test Reports | MTR | MTR–Type Name |
| Operations & Maintenance Data | OM | OM–Type Name |
| Product Certificates | PC | PC–Type Name |
| Product Data | PD | PD–Type Name |
| Spare Parts List | SP | SP–Type Name |
| Material Warranty | MW | MW–Type Name |
| Field Test Reports | FTR | FTR–Component Name–Description of document (optional) |
| Start-up Reports | SR | SR–Component Name–Description of document (optional) |
| Test & Balance Reports | TAB | TAB–Description of document |

END OF TABLE

Document Naming Convention

As an example, assume there is an HVAC system with multiple air handling units of Type AHU0001 in building 1900006.

The naming convention for System level reports will be:

Document Code – Description of the document

System example: TAB-HVACSupplyLevel3

The naming convention for Type level reports will be:

Document Code – Type Name

Type example: PD-1900006-AHU0001

The naming convention for Component level reports will be:

Document Code – Component Name – Description of the document

SR-HVAC-1900006-AHU0001-12-001-TraneUnitStartUp

Or: SR-HVAC-1900006-AHU0001-12-001

Appendix F – BIM Execution Plan Outline – Contractors

The following outline indicates the minimum information to be included in a BEP on State of Tennessee projects. Additional information may be included in the BEP as deemed appropriate by the owner, designer and contractor or as otherwise required by these BIM Standards.

Project Information

- Identify project name, SBC number, location (address & geo-reference)
- Identify owner
- Identify effective date or revision date of plan

Project Construction Team Information

- Contractor firm
 - Firm name
 - Firm address
 - BIM manager name
 - BIM manager contact information
- subcontractors and Major Suppliers
 - Firm name
 - Firm address
 - BIM coordinator name
 - BIM coordinator contact information

BIM Goals and Objectives

- Identify owner's intended goals or end uses of the BIM
- Identify Contractor, subcontractors, and major suppliers uses of the BIMs during the project
- Organization responsible for each Construction BIM
- List of Construction BIMs to be delivered

Roles and Responsibilities

- Briefly describe each organization's responsibility for:
 - BIM creation
 - BIM quality
 - BIM analyses
 - BIM management
- Identify BIM software product and version to be used by each organization
- Describe the roles of the BIM Manager and the BIM Coordinators

Software for Model Authoring

- Identify all software products to be used for BIM creation/updating and the software version
- Identify all object enablers to be used for viewing BIMs
- Identify all software products to be used for BIM Coordination and interference reporting
- Identify software products that will be used to perform quality control on BIMs

Modeling Standards and Content

- Common coordinate system
 - Units
 - File origin (X,Y,Z)
 - Geolocation
- Modeling partitions
- File versioning
- Naming
 - Files
 - Building level designators
 - Building area designators
 - Discipline designators
 - Layers (if applicable)
 - Properties required for:
 - COBie deliverables
 - Owner-requested analyses
 - Construction-initiated analyses
 - Units and values for properties (e.g.- cubic feet per minute, space use codes from FICM)
- Level of precision and dimensioning
- Objects to be modeled per discipline or trade
- BIMs shall include clearances for access, maintenance, and code requirements
- Object properties to be included
- Equipment tags
- Any exclusions from the Construction BIMs

Construction Phase Analyses,

- Each analysis that will be performed:
 - Software to be used
 - BIM(s) to be analyzed
 - File format required
 - Responsible team member(s) for
 - Performing the analysis
 - Producing the required BIM(s)

BIM Kickoff Meeting

- Identify the required and optional attendees
- Identify the meeting location and date
- Identify the agenda of the kickoff meeting.
 - Sample agenda could include:
 - BIM expectations
 - Project goals
 - BIM coordination process
 - BIM coordination meetings
 - COBie data capture process
 - COBie coordination meetings
 - Other BIM analyses such as 4D Scheduling
 - Discuss BIM Execution Plan
 - Discuss modeling standards
 - Discuss model content
 - COBie deliverables and requirements
 - BIM deliverables
 - Discuss any software limitations that may affect deliverables

Collaboration Plan

- Describe the collaboration and file sharing system(s) to be used to exchange, merge, identify interferences and visualize BIMs
- Describe the collaboration and file sharing system to be used for data aggregation from and assigning data responsibility to team members
- Describe the method to be used to capture required equipment attributes as data during Submittals and Installation
- Describe the system(s) to be used to exchange other electronic documents such as meeting minutes, meeting agendas, and interference reports
- Describe the hardware and software to be provided for onsite viewing of Coordination BIMs
- Identify owner-accessible files, versions and read/write privileges

BIM Coordination

- Describe the roles and responsibilities of required Project Team members for BIM coordination
- Describe the schedule for or frequency of model updates and interference checks
- Describe tools to be used for BIM coordination
- Define the clashes to be run (e.g. HVAC vs. Structure)
- Describe the process to identify and resolve interferences
- Describe the process for tracking action items from the meeting.
- Describe the process for tracking changes to the Coordination BIMs
- Describe the process to be used to generate related shop drawings and coordination drawings from the coordinated Construction BIMs

BIM Coordination Meetings

- Identify the frequency of meetings
- Identify the required and optional attendees
- Identify the locations of the meetings

COBie Coordination

- Describe the roles and responsibilities of required Project Team members for COBie data capture
- Discuss the tool(s) to be used to aggregate the data from multiple parties
- Describe the method for capturing required equipment Attributes, as defined in Appendices D during product submittals
- Describe the method for frequency of QA/QC of COBie data

COBie Coordination Meetings

- Identify the frequency of meetings
- Identify the required and optional attendees
- Identify the locations of the meetings

BIM Deliverables

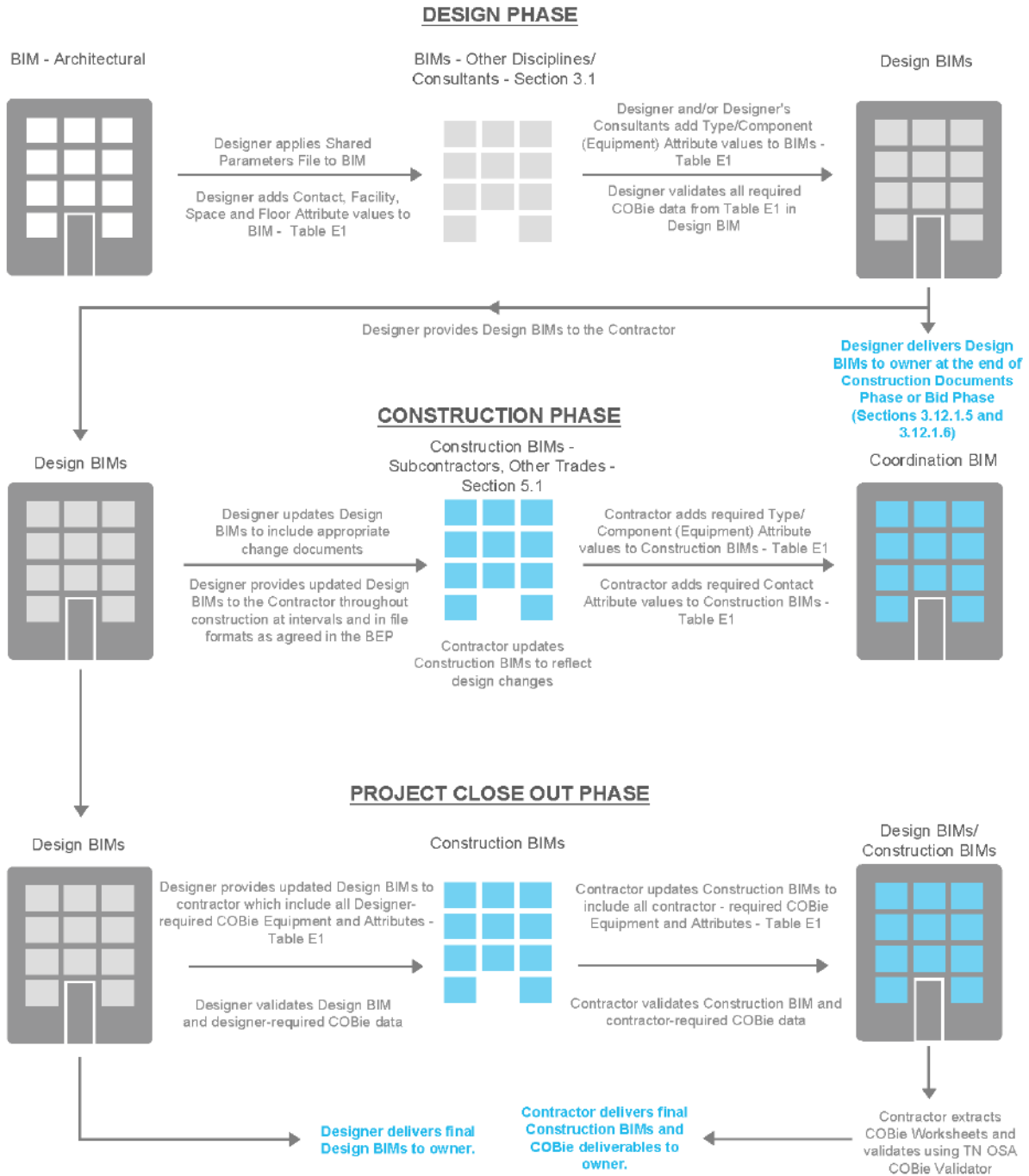
- Identify electronic models, drawings, analyses, data and reports, to be delivered
- Identify all types and attributes to be included in the COBie deliverables
- Describe technique for merging COBie data produced by multiple parties
- Describe process to be used to extract all BIM and drawing deliverables from the coordinated, Construction BIMs
- Identify the file formats for all deliverables
- Describe process to be used to aggregate and deliver COBie documents
- Describe quality assurance and quality control measures to be implemented

Sign-Off

- Authorized signature from the Contractor, Subcontractors, and Major Suppliers indicating agreement to comply with this BIM Execution Plan

Appendix G – BIM Process Map

The *BIM Process Map* below illustrates a general progression of BIM model development and how BIM will be applied on a project including associated activities and information exchanges from project design through project close out. See Sections 3.12 and 5.11 for more information regarding designer and contractor BIM deliverables by project phase.



Appendix H – Change Log

1. Section 1: Clarified that these BIM Standards are meant to be outcome based.
2. Section 2: Clarified definitions.
3. Section 3: Clarified material and addressed concerns raised from the Industry and pilot teams.
4. Section 4: Updated to capture and reflect changes made in Section 3.
5. Section 5: Clarified material and addressed concerns raised from pilot teams.
6. Section 6: Updated to capture and reflect changes made in Section 5.
7. Appendix A: Clarified the clash detection reporting requirement for designers.
8. Appendix B: No changes.
9. Appendix C: Updated to include requirement that higher education projects use an un-altered form of FICM for classifying spaces. Included naming for floors. Shortened the included OmniClass Table 13 list.
10. Appendix D: Updated attribute requirements based on feedback from industry, STREAM, JLL, and pilot teams.
11. Appendix E: New. Created to address request for a brief COBie primer.
12. Appendix F: New. Contains the document naming standards and requirements that were originally included in Appendix D.
13. Appendix G: Renamed; this was the old Appendix E. Updated to include additional feedback from pilot teams.

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14. Section 1: Removed Section 1.3 Incremental BIM Adoption
15. Section 2: Removed Section 2 Obligation to Use BIM and General Principles
16. Section 2: Moved Section 2.1.7 to Section 2.2 Risk Allocation
17. Section 2: Revised/Added Definitions
18. Section 3: Revised Building Number requirement, Section 3.4, Clarified Existing Conditions, Section 3.6
19. Section 3: Added Section 3.11 BIM Methodology to consolidate previous Section 3.10 Well-Structured BIM
20. Section 3: Revised Section 3.12 BIM Deliverables by Phase - designer
21. Section 4: Revised Section 4 to align with Section 3.12 revisions
22. Section 5: Removed Architectural and Structural Proxy BIMs (Section 5.1), Revised Building Number requirements (Section 5.4), Added Reference to Section 3.11 BIM Methodology
23. Section 5: Revised BIM Deliverable – contractor (Section 5.11)
24. Section 6: Revised Section 6 to align with Section 5.11 revisions
25. Appendix D: Specified an Abbreviated Component Tag format
26. Appendix D: Added Table D1, Attribute Groups to simplify table D2

27. Appendix D: Table D2, Consolidated Equipment Naming Standards and Attribute Table including OmniClass 23 mapping and Attribute Groups, Table D1 reference
28. Appendix E: Added Table E1 to clarify BIM Attribute/Parameter Values by responsibility, BIM Type and Project Stage.
29. Appendix E: Moved COBie Field Requirements from Appendix F to Appendix E.
30. Appendix G: Added BIM Process Map to clarify how BIM will be applied on projects including associated activities and information exchanges.

31. BIMs Section 3.5. Geo-referencing – Updated the requirements for expressing units when using the Tennessee State Plane Coordinate System

SECTION 1. Tenn. Code Ann. § 66-6-102, is amended by deleting the section and substituting:

*The plane coordinate values for a point on the earth's surface, used to express the geographic position or location of such point, must consist of two (2) distances expressed in United States survey feet and decimals of a foot when using the Tennessee Coordinate System of 1927, expressed in either United States survey feet and decimals of a foot or meters and decimals of a meter when using the Tennessee Coordinate System of 1983, and **expressed in either International feet and decimals of a foot or meters and decimals of a meter when using the Tennessee State Plane Coordinate System.** One (1) of these distances, to be known as the "East X-coordinate," must give the distance east of the Y axis; the other, to be known as the "North Y-coordinate," must give the distance north of the X axis. The Y axis of any zone must be parallel with the central meridian of that zone. The X axis of any zone must be at right angles to the central meridian of that zone.*