Table of Contents

1. Introduction
   1.1. BIM Goals
       1.1.1. Visualization
       1.1.2. Collaboration
       1.1.3. Construction Coordination/ Facilities Management
   1.2. Intent of BIM Specification
       1.2.1. Risk Reduction
   1.3. Unique nature of projects
   1.4. Qualities of Project Team
   1.5. Design Standard
   1.6. Definitions

2. Requirements
   2.1. General
       2.1.1. Early use of BIM
   2.2. BIM Requirements/ Deviations
   2.3. Controlling Documents
       2.3.1. Two-Dimensional Documents Control
       2.3.2. Drawings to be Consistent with Model
       2.3.3. Use of the Model to Determine Quantities
   2.4. BIM Models and Responsibilities
       2.4.1. BIM Execution Plan
       2.4.2. Model Progress
       2.4.3. Sharing of Models
       2.4.4. As-Built Model
       2.4.5. Design Model Roles and Responsibilities
       2.4.6. Construction Model Roles and Responsibilities
   2.5. File Sharing Platform
       2.5.1. General
       2.5.2. Design Model
       2.5.3. Construction Model
   2.6. Software
       2.6.1. Version
   2.7. Scale, Datum, Horizontal and Vertical References
       2.7.1. Definitions
       2.7.2. Project North
       2.7.3. Coordination between models
   2.8. File Structure
       2.8.1. Design Models
       2.8.2. Construction Models
   2.9. File Naming
       2.9.1. General
       2.9.2. Example
   2.10. File formats
       2.10.1. Table of Formats
2.10.2. File Publishing/ Archiving

2.11. Model Structure and Modeling Techniques within Files
   2.11.1. General
   2.11.2. Design Models
   2.11.3. Construction/ As-Built Models

3. Processes Responsibilities and deliverables
   3.1. General requirements
      3.1.1. BIM Execution Plan (BIP)
      3.1.2. Level of Model Development
   3.2. Design Phase Requirements
      3.2.1. Progression of models
      3.2.2. BIM Lead Transition
      3.2.3. Responsibilities in the Design Phase for the Architect
      3.2.4. Responsibilities in the Design Phase for the Contractor
   3.3. Construction Phase Requirements
      3.3.1. Coordination of BIP Process
      3.3.2. Responsibilities in the Construction Phase for the Architect-Engineer
      3.3.3. Responsibilities in the Construction Phase for the Contractor
   3.4. As-Built models
      3.4.1. Responsibilities
      3.4.2. Process
   3.5. Record models
      3.5.1. General

Attachments (click below to open files)

   A. BIM Execution Plan Template
   B. Model Level of Development Matrix
   C. Maintainable items sample list
   D. Process to set up property data sets in AutoCAD based applications
1. Introduction

1.1. BIM Goals: In promoting the use of building information modeling (BIM) 3D technology, Princeton University will continue to achieve the highest quality building design, enabling measurable improvements to the design and construction of capital projects resulting in higher quality building projects and savings in cost and time.

1.1.1. Visualization: The Design Model will, by way of its capacity to provide enhanced 3D visualization and analysis, improve the Project Team’s effectiveness in sharing the concept-level design with clients including the Princeton University development office, program clients, and other stakeholders. As the design progresses BIM will enhance the Project Team’s ability to visualize the design, prove the design concept, and cooperatively coordinate building systems. This will provide increased confidence in the coordination of major structural, architectural and MEP systems. The Design Model may also support sustainability studies such as energy modeling, day lighting and sun shade analysis.

1.1.2. Collaboration: The Contractor’s involvement during the development of the design will provide for constructability insight related to sequencing and physical coordination of the project. BIM may also be used to facilitate order of magnitude quantity take-offs, site logistics studies, 4D scheduling and general coordination reviews. Periodic web-based design review sessions will be used to share progress as the design evolves into the construction phase.

1.1.3. Construction Coordination/ Facilities Management: The Design Model will be used as a reference document and will establish the format for the Construction Model. During the construction phase the Contractor will replace the structural, mechanical, electrical and other selected systems in the Design Model with a fully integrated, coordinated Construction Model that will serve as Princeton University’s As-Built Model. This As-Built Model will be embedded with maintainable building components. A specific list of maintainable items to be embedded in, or linked through the model will be established on a project by project basis by Princeton University.

1.2. Intent of BIM Specification: This BIM Specification includes the requirements for all projects utilizing BIM, but also provides a framework to determine project specific BIM goals, processes and protocols. The BIM Execution Plan Template and BIM Level of Development Matrix, included as attachments, are principal tools to be utilized by Project Teams to plan the use of BIM. BIM, along with other collaborative tools, is intended to promote integrated, efficient design without prescribing burdensome requirements that may diminish the final building project quality.
1.2.1. Risk Reduction: While increasing collaboration and value, BIM also will reduce risk to the Project Team by:

1.2.1.1. Increasing visualization which will reduce Princeton University-generated changes.
1.2.1.2. Improving design coordination by using 3D technology to generate construction documents.
1.2.1.3. Increasing contractor confidence through improved visualization and building coordination.
1.2.1.4. Reducing coordination-related change orders in the construction phase.
1.2.1.5. Promoting pre-fabrication of material assemblies during construction which reduces field labor and cost.
1.2.1.6. Providing Princeton University with an intelligent as-built model to streamline the project turnover process and promote improved start up and facility management.

1.3. Unique nature of projects: Princeton University recognizes that each project type brings unique challenges and many possible solutions for building design and construction, and encourages each team to use these guidelines to establish the highest and best use of the technology as it relates to the specific project type. In addition to these guidelines, Project Teams will utilize a project-level BIM Execution Plan (BEP) template for documenting the planned use of BIM, including processes, roles and responsibilities and other protocols for the project duration.

1.4. Qualities of Project Team: Princeton University recognizes BIM as an emerging tool and encourages Project Team to share the range and depth of their experience during the BIM implementation planning stage to increase value. For example, the Architect/ Engineer may have unique office standards and approaches that may prove valuable for a specific project, yet may not be called out as a requirement. The Project Team is encouraged to include such ideas in the planning stages so the project may benefit through these synergies.

1.5. Design Standards: The Princeton University Design Standards are the governing document with respect to design and construction deliverables. This BIM Specification is to be used in conjunction with the Design Standards, and is not intended to replace or supersed the Design Standards or other contractual documents.

1.6. Definitions

<table>
<thead>
<tr>
<th>Concept</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>As-Built Model</td>
<td>The As-Built Model constitutes actual as-built conditions as installed.</td>
</tr>
<tr>
<td></td>
<td>The As-Built Model also contains additional data such as equipment</td>
</tr>
<tr>
<td></td>
<td>property data and hyperlinks to related documents.</td>
</tr>
<tr>
<td><strong>BIM Lead</strong></td>
<td>Individual representing Project Team member serving as the point of contact for organizational and administrative matters pertaining to BIM Model. Individual will have experience and authority necessary to efficiently manage project responsibilities pertaining to BIM.</td>
</tr>
<tr>
<td><strong>Component Model</strong></td>
<td>A specific Design Model or Construction Model that is created by a project participant and represents the building system discipline(s) that the project participant is responsible for with respect to providing design or submittal related information. (i.e. lab casework, curtain wall, HVAC piping, etc.)</td>
</tr>
<tr>
<td><strong>Construction Model</strong></td>
<td>A model or entirety of models created by the Contractor or subcontractor that represents design intent and the physical relationship of building system and from which submittals, shop drawings and as-built documents are derived.</td>
</tr>
<tr>
<td><strong>Design Model</strong></td>
<td>A model or entirety of models created by the Project Team that represents the design intent and from which the design drawings are derived.</td>
</tr>
<tr>
<td><strong>Federated Model</strong></td>
<td>A compilation of Component Models in a model review tool in which the individual Component Models are overlaid and at the same time are distinct from each other.</td>
</tr>
<tr>
<td><strong>Governing Contract</strong></td>
<td>The agreement between Princeton University and the particular Project Team member that governs Princeton’s relationship with that Project Team Member for the relevant Project.</td>
</tr>
<tr>
<td><strong>Model</strong></td>
<td>Any model created by the BIM software, including, without limitation, an As-Built Model, a Component Model, a Construction Model, a Design Model, a Federated Model, or a Record Model.</td>
</tr>
<tr>
<td><strong>Model Author</strong></td>
<td>The Project Team Member who created a Model</td>
</tr>
<tr>
<td><strong>Princeton University Property Data Set:</strong></td>
<td>Custom data set defined in AutoCAD MEP or other AutoCAD-based applications that can handle object data for additional element specific property data. A baseline version of the dataset includes fields for Room Number, System and Tag. The detailed steps for setting up Property Data Sets in AutoCAD MEP are included in Attachment XX</td>
</tr>
<tr>
<td><strong>Project Team</strong></td>
<td>Project participants consisting of Architect, sub-consultants, Contractor, sub-contractors and Princeton University representatives.</td>
</tr>
<tr>
<td><strong>Record Model:</strong></td>
<td>The Record Model is the entirety of component models that represent the final design, including construction phase design revisions and other drawing revisions. The Record Model is provided to Princeton University at Project Completion.</td>
</tr>
</tbody>
</table>

2. **Requirements**

2.1. **General:** This section covers requirements and processes that will be utilized throughout project and apply to this section and subsequent BIM Specification sections and attachments.
Princeton University BIM Specification

2.1.1. Early use of BIM: Project Teams will consider the use of models early in the design process to promote simple, rapid creation of options which can be easily manipulated for collaborative reviews and workshops with Princeton University. These workshops are outlined in the Design Standards and include sessions such as conceptual design reviews, sustainability charrettes and life cycle cost analyses.

2.2. BIM Requirements/ Deviations: Any deviation from this BIM Specification requires the written approval of Princeton University.

2.3. Controlling Documents

2.3.1. Two-Dimensional Documents Control: The BIM model is to be used solely as a reference for visualization and to achieve other goals outlined in this specification. The two-dimensional (2D) documents generated by the design team (including, without limitation, construction drawings and plans, shop drawings, submittals, and the like), shall be the operative and controlling documents for the Project. In the case of any conflict between the 2D documents and the BIM Model, the information and data contained in 2D documentation shall take precedence over the three-dimensional (3D) BIM model.

2.3.2. Drawings to be Consistent with Model: All drawings created on the project, including, without limitation, design drawings, ASI’s, shop drawings, sketches for RFI responses shall be consistent with the Design or Construction Model to the greatest extent possible. It is the responsibility of the author of a drawing to ensure that the drawing is consistent with the information represented in the corresponding Model. The Model Author’s legal liability shall be determined by the content of the 2D drawings, not by the content of the 3D BIM Model.

2.3.3. Use of the Model to Determine Quantities: It is the responsibility of the Contractor or subcontractor to determine the appropriateness of any BIM Model for establishing quantities. In accordance with Section 2.3.1 above, the content of 2D drawings shall control any quantity determination by a Contractor or subcontractor. The authoring Project Team member is not responsible for any outcomes of uses of a model by other Project Team members.

2.4. BIM Models and Responsibilities: As part of their respective responsibilities under their Governing Contract, Princeton’s Design Standards, and this BIM Specification, each Project Team member shall have specific responsibilities with respect to the use of BIM on the Project. The following is an overview of BIM-related roles and responsibilities, which will be more fully described in the BIM Execution Plan (BEP).

2.4.1. BIM Execution Plan: The Project Team will submit the BEP within 30 days of contract execution. The architect shall be primarily responsible for coordinating and submitting the
BEP, and other Project Team members shall cooperate fully with the architect to ensure the timely completion and submission of the BEP.

2.4.2 **Model Progress:** Progress of the BIM model and related documentation will be measured to align with milestones established in the BIP.

2.4.3 **Sharing of Models:** At appropriate points during the creation of the BIM Model, or as set forth in the BEP, each Model Author shall share respective model(s) with other Project Team members.

2.4.4 **As-Built Model:** Princeton University recognizes the complementary nature of the Design and Construction Models that are created during the Project and that, at the end of the project, components from both models will be compiled into an As-Built Model. For example, the architectural design model may be used as background for individual trade Component Models as part of the Construction Model, and eventually the As-Built Model

2.4.5 **Design Model Roles and Responsibilities:** Unless otherwise specified in the BEP, the architect shall be responsible for the creation, coordination and delivery of the design documents and BIM Design Model.

2.4.5.1 **Coordination:** The architect will create the architectural model, and lead the coordination and establishment of protocols related to sub-consultant Component Models such as structural, mechanical, fire protection, and furniture. Sub-consultants will be sole authors of respective Component Models. The architect will lead process to create a Federated Model.

2.4.5.2 **Record Model:** During the construction phase the Architect-Engineer will make model revisions necessary to issue bulletins, answer requests for information (RFI’s) and issue 2D drawings in connection with design intent or clarifications. The final copy of Record Model, in addition to final documentation outlined in Design Standards, will be turned over to Princeton University at project completion.

2.4.5.3 **Constructability:** During the design phases Contractor and Princeton University will participate in periodic reviews of Federated Model to assure alignment with project goals and to promote efficient constructability of the work

2.4.5.4 **Protocols:** Protocols, processes and procedures shall be established by the architect as part of the BEP to promote organized information exchange, file safety and posting of individual and Federated Models for view by Project Team. Periodically, but no less than monthly, the Design Model will be posted for view by Princeton University, and any other Project Team member designated by Princeton University.
2.4.6. **Construction Model Roles and Responsibilities:** The Contractor will assume lead responsibilities for the Construction Model. Accordingly the Contractor will assume the lead role in to integrate construction phase BIM processes and protocols into the BIM Execution Plan. The Project Team will continue to contribute to the construction phase BEP.

2.4.6.1. **Architectural Framework for Construction Model:** The Architect-Engineer will provide the Design Models necessary as a reference to enable the Contractor, including respective sub-contractors, to build individual trade Component Models (Construction Models). The Design Models will be provided in their latest version throughout the design and construction process, according to the schedule set forth in the BEP.

2.4.6.2. **Coordination:** The Contractor will lead and coordinate the creation of sub-contractor trade Component Models and will establish protocols related to creation, review and management of Component Models. The Contractor will lead process to create a construction phase Federated Model.

2.4.6.3. **As-Built Model:** During the construction phase the Contractor will make revisions necessary in the Construction Model to reflect as-built conditions. Attributes, property sets, tagging and other facility management-related information, as outlined in this Specification and in the BEP, are considered part of these requirements. Update of Construction Model will occur concurrently with construction progress and will be validated at periodic meetings with Princeton University.

2.4.6.4. **Protocols:** Protocols, processes and procedures will be established by Contractor as part of the BEP to promote organized information exchange, file safety and posting of individual and Federated Models for view by Project Team. Periodically, but no less than monthly, the Construction Model will be posted for view by Princeton University.

2.5. **File Sharing Platform:**

2.5.1. **General:** The File Sharing Platform must:

2.5.1.1. be able to handle files up to 500MB,
2.5.1.2. support user administration, including component model author tracking,
2.5.1.3. contain an archive of versions and revisions of the relevant models and documents,
2.5.1.4. provide appropriate email-notification to support efficient workflows,
2.5.1.5. be secure and only allow authorized and authenticated users access to the project on the platform.

2.5.2. **Design Model:** The Architect-Engineer shall provide a file sharing platform for hosting Design Models and internal communication among the Project Team.

2.5.3. **Construction Model:** The Contractor shall provide a file sharing platform for hosting Construction Models and communication with subcontractors.

2.6. **Software:** The tools listed in Table 1 are required for the respective models. Deviations shall be approved in writing by Princeton University.

2.6.1. **Version:** Software used by the Project Team shall be in the most current version yet allow for a stable environment that is conducive to efficient use of BIM and project delivery. Individual project participants must coordinate version change with respective BIM lead.

On the project the following systems are required:

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Type of Model</th>
<th>BIM Authoring Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architectural Design</td>
<td>Design Model</td>
<td>Autodesk Revit Architecture</td>
</tr>
<tr>
<td>Structural Design</td>
<td>Design Model</td>
<td>Autodesk Revit Structure or Tekla</td>
</tr>
<tr>
<td>MEP FP Design</td>
<td>Design Model</td>
<td>Autocad MEP or Autodesk Revit MEP</td>
</tr>
<tr>
<td>Civil Design</td>
<td>Design Model</td>
<td>AutoCAD Civil 3D</td>
</tr>
<tr>
<td>Other</td>
<td>Design Model</td>
<td>Autodesk Revit Tool (any) or in exceptional cases to be coordinated with Princeton University</td>
</tr>
<tr>
<td>Building Systems (e.g. MEP, FP, data, security etc.)</td>
<td>Construction Model</td>
<td>Tool of choice of project participant; Specific Requirements for Building Systems Models shall be met*</td>
</tr>
<tr>
<td>Other Construction Models</td>
<td>Construction Model</td>
<td>Tool of choice of project participant; Specific Requirements for Other Construction Models shall be met**</td>
</tr>
</tbody>
</table>

*Specific requirements for tools for Building Systems Construction Models:
- Export of model to *.dwg file format
- Definition of customized data sets (see Attachment D for instructions/details)
Princeton University BIM Specification

- Geometrical data and customized object property data (data sets) need to be transported to Navisworks without data loss.

**Specific Requirements for Other Construction Models**
- Export of model to *.dwg file format
- Geometrical data needs to be transported to Navisworks without data loss.

2.7. Scale, Datum, Horizontal and Vertical References:

2.7.1. Datum: All objects in models are to be modeled at true scale and at true elevation above sea level in accordance with the datum to be provided by Princeton University.

2.7.2. Definitions: For the purpose of specifying horizontal locations and orientations of objects in models and drawings the following definitions apply:

2.7.2.1. True North: Orientation of objects in a model or a drawing in accordance with the geographical North orientation. Locations have the correct coordinates in accordance with the state plane coordinate system of New Jersey.

2.7.2.2. Project North: Objects in a model are oriented for convenience of the modeling and drafting process. Project North is one defined orientation and location of the building defined by the Architect-Engineer and followed by all project participants.

2.7.3. Project North: All models and documents shall follow the Project North orientation and location.

2.7.4. Coordination between models: To ensure alignment and coordination between Component Models, and between Design Models and Construction Models (DWG files), the Architect-Engineer shall provide:

2.7.4.1. Gridlines of the project in the Project North coordinate system in *.dwg AutoCAD file format.

2.7.4.2. Elevation lines of floors (top of finished floor elevation) in *.dwg AutoCAD file format.

2.8. File Structure: Project Team shall establish file size protocol in BEP.
2.8.1. **Design Models**: Design Model files shall be kept at reasonable sizes so that project participants with typical computing equipment are able to open and review the models. If files become too large for some project participants to handle or use, the models must be reduced in size (e.g. split) so that practical file sizes are attained. The actual size of a file is only one indicator as to whether a file is too large. Some files of moderate size, but with difficult object structures represented in the file, may also need to be split for acceptable system operation. For Revit files then recommended file size limit is 200MB for 64 Bit workstations.

2.8.2. **Construction Models**: Based on input from Project Team, The Contractor will facilitate, define and document a file structure for Construction Model files in the BEP. File size shall be managed so that project participants accessing model can work with the model if they utilize workstations typical for BIM work. If sizes are too big for acceptable performance on project participants’ computer systems, the files must be split so that acceptable system operation is achieved. The following limits are recommended; a. pure AutoCAD files: 50MB, AutoCAD Extension-based files (e.g. Quickpen, CAD duct: 10MB.

2.9. **File Naming:**

2.9.1. **General**: Files will be named in a manner that is descriptive of the content of the file, the authoring party, version and date. The detailed nomenclature for files will be confirmed with the Project Team in the BEP. Files shall be saved to the latest version of the respective software. Files shall be named so that the filename contains the following information:

- **2.9.1.1.** Project name
- **2.9.1.2.** Authoring party
- **2.9.1.3.** Phase of the project
- **2.9.1.4.** Discipline or trade represented in the file
- **2.9.1.5.** Level in the building represented in the file (if applicable)
- **2.9.1.6.** Zone/Area in the building represented in the file (e.g. North Wing or South Wing) (if applicable)
- **2.9.1.7.** Version Number of the file (running number in an iterative modeling process)
- **2.9.1.8.** Data Date when the file was published for the use of the team

2.9.2. **Example:**

- **Design Model Revit File:** SMITH HALL JONES ARCH_DES_ARC-CS_V0005_2011-02-22.rvt

  - **2.9.2.1.1.** Project = SMITH HALL
  - **2.9.2.1.2.** Authoring Party = JONES ARCH - Jones Architects
  - **2.9.2.1.3.** Phase of the Project = DES - Design Phase
  - **2.9.2.1.4.** Discipline = ARC-CS – Core and Shell Architecture
  - **2.9.2.1.5.** Version = V0005
  - **2.9.2.1.6.** Data Date = 2011-02-22
2.9.2.2. Construction Model Revit File:

- SMITH HALL_JSM_CON_DUCT_L02_ZA_V0007_2011-02-22.dwg
- Project = SMITH HALL
- Authoring Party = JSM – Jones Sheet Metal Co.
- Phase of the Project = CON – Construction Phase
- Discipline = DUCT – Ductwork
- Level = L02 – Level 2
- Zone = ZA – Zone A
- Version = V0007
- Data Date = 2011-02-22

2.10. File formats:

2.10.1. Table 2.10.1: The following file formats will be made available to the Project Team.

<table>
<thead>
<tr>
<th>Model</th>
<th>File Formats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Model</td>
<td>Autodesk Revit File format *.rvt and Export of 3D model to AutoCAD *.3D.dwg format.</td>
</tr>
<tr>
<td>Construction Model of the building systems trades (e.g. mechanical, electrical, plumbing, ductwork, controls, Fire Protection etc.)</td>
<td>*.dwg file format with object property data sets, see attachment D</td>
</tr>
<tr>
<td>Construction Model other trades</td>
<td>AutoCAD *.dwg file format</td>
</tr>
<tr>
<td>Record Model</td>
<td>Component Models in the native file format in which the model was created, and in AutoCAD *.dwg file format.</td>
</tr>
<tr>
<td>As-Built Model</td>
<td>Component Models in the native file format in which the model was created, and in AutoCAD *.dwg file format.</td>
</tr>
</tbody>
</table>

2.10.2. File Publishing/Archiving: During all project phases, the Architect/Engineer or Contractor shall archive and make all versions of published files of respective Models accessible to the Project Team.

2.11. Model Structure and Modeling Techniques within Files

2.11.1. General: Project Team shall confirm and document Model structure and techniques in BEP.

2.11.1.1. Duplication: No duplication of objects between models. Unintended duplications of objects shall be removed from models.
2.11.2. **Objects**: Dedicated, classified, named building objects shall be used whenever possible to express design intent rather than generic geometrical forms. For example, use ready-made objects of object families that promote the ability to search by object attributes.

2.11.3. **Conflicts**: Within one model no two objects shall be depicted in the same space or in conflict with each other. (e.g., column object and slab object intersecting). Exceptions: conditions that don’t need to be coordinate such as drywall penetrations.

2.11.4. **Cleanup of models**: Component Models shall only include content as defined in the BEP. Objects from other trades and objects outside the intended purpose of the model (e.g. objects “parked” outside the building for future integration into the model) shall be removed prior to publishing models.

2.11.5. **Links**: External links shall be removed prior to publishing models.

### 2.11.2. Design Models

2.11.2.1. **Depiction of space**: Space: Room, zone and space objects shall be represented in the architectural model. Room and space objects shall reach to the face of the confining walls.

### 2.11.3. Construction Models/ As-Built Models

2.11.3.1. **Layers**: The layer structure (*.dwg files) shall follow the structure outlined in the BEP. The layer names for Construction Models shall be submitted to Princeton University for approval.

2.11.4. **Ownership and Use of Models**: Use of the Models is subject to clauses G2 and I4 of the General Terms and Conditions for All Construction Contracts and Articles XII(g) and XIII of the Architect/Engineer Design Services Contract.

### 3. Processes Responsibilities and deliverables

#### 3.1. General requirements

3.1.1. **BIM Execution Plan (BEP)**: The BIM Execution Plan, which is generally outlined here and described in detail in the BIM Execution Plan template (attachment A), is a working tool to be utilized by the Project Team continuously as the project evolves. The BEP template provides a working framework to enable the Project Team to develop a customized plan for attaining BIM goals unique to the project. The BEP shall define BIM goals, information exchange protocols, file naming, schedule for BIM meetings, BIM Leads, and establish a
process for tracking progress for BIM related tasks. BEP will include requirements for project-specific BIM scope as identified in project request-for-proposal (RFP) such as laser scanning and digital terrain models. At project inception, the Project Team, led by the architect, will establish the BEP and submit to Princeton University for approval. The Contractor will lead the BIM efforts as the project transitions to construction phase, including additions and refinements to the BEP. The BEP will be revised as the project progresses to capture emerging goals, develop model requirements and establish model-management protocols.

3.1.1. Communication: As defined in BEP, Project team will engage in BIM workshops and meetings to track progress towards completion.

3.1.2. Level of Model Development: Attachment B – Model Level of Development Matrix defines model content for each phase of the project. The matrix includes minimum model content and provides an area to document content that the project team determines to be required that may be unique to the project goals. The Model Level of Development Matrix shall be reviewed periodically, but at least monthly, to confirm alignment with BEP.

3.2. Design Phase Requirements

3.2.1. Progression of Models: In early design phases simplistic models with limited level of detail, shall be created. As the design progresses the existing limited detail components shall be replaced with more detailed components. The level of detail represented in the model shall correspond with level BEP and Model Level of Development Matrix.

3.2.2. BIM Lead Transition: Project Team is encouraged to establish a timeframe for the planning and development the construction phase aspects of the BEP activities. Project Team shall begin work on construction phase BEP as early in the design phase as is practicable, but planning for the construction phase BIP will begin no later than 50% construction drawing milestone. This will enable construction phase BIP and subcontractor responsibilities to be coordinated at the time of 85% drawing completion, and well before bidding begins.

3.2.3. Responsibilities in the Design Phase for the Architect-Engineer include but are not limited to:

3.2.3.1. BEP: Leading BEP kickoff meetings, workshops and BEP documentation process.

3.2.3.2. Coordination: Implementation of a model-based design coordination process, which includes identification, documentation and resolution of constructability issues. The coordination process shall be structured, transparent and organized to promote participation of the Project Team.
3.2.3.3. **Quantities:** Coordinating modeling techniques and strategies with the Project Team to achieve a high level of utility of design models for the process of extracting quantity information from models.

3.2.3.4. **Maintainable Items:** To enable the post-project-completion use of the As-Built Model for building maintenance by Princeton University a list of maintainable items will be provided by Princeton University to the Project Team, for use in assembling and linking building element information, such as operations and maintenance manuals and warranty information, to the As-Built Model. Sample Maintainable Items List is shown in Attachment C. Architect-Engineer will insert unique tags in Design Model to enable elements to be tracked and related information to be linked during future project phases.

3.2.3.5. **Areas, zones:** Project Team will engage in BIM workshop at project inception (Preliminary Design Phase or Schematic Design Phase) to establish project specific room names, zones and other attributes to be contained in model, such as departments, security zones, and other building uses as defined by Princeton University. These areas and zones will be documented in the BIP and tracked during project duration, through the construction phase and within the Record and As-Built Models. The zones shall be represented in the architectural model and exported into zone definition files.

3.2.3.6. **General Organization:** Model shall be constructed to enable automatic extraction of program and other building information and to enable the creation of multiple options during early design phases.

3.2.4. **Responsibilities in the Design Phase for the Contractor** include, but are not limited to:

3.2.4.1. **Coordination of modeling** techniques and strategies within the Project Team to promote:

3.2.4.1.1. Effective constructability reviews.
3.2.4.1.2. Extraction of quantities of building elements and systems for ease of evaluation where practical.

3.2.4.2. **Color Coding:** Utilize color coding of systems and components to effectively communicate project scope to bidding subcontractors.

3.2.4.3. **Procurement strategy:** Planning BIM related scope and purchasing of the appropriate scope from subcontractors for an effective model based coordination process in accordance with the BIP.
3.3. Construction Phase Requirements

3.3.1. Coordination of BIP process: Contractor shall schedule required meetings, prepare updates of BIP for comment and distribute BIM requirements as part of bidding process to sub-contractors.

3.3.2. Responsibilities in the Construction Phase for the Architect-Engineer include but are not limited to:

3.3.2.1. Responding to requests by the Contractor to resolve coordination and constructability issues. The developed solutions shall be represented in the Design Model and made available to the Contractor for the purpose of validating constructability and other relevant issues.

3.3.2.2. When issuing design clarifications, changes or responses to RFI’s, the Architect-Engineer shall generate drawings from the BIM model. The Architect-Engineer shall take conditions shown in the Construction Model into consideration when issuing design changes, ASIs and RFI responses.

3.3.2.3. Preparation of Record Models as described in this guideline and in the BIM Execution Plan.

3.3.3. Responsibilities in the construction phase for Contractor include, but are not limited to:

3.3.3.1. Coordination: Establishing and managing a model-based coordination process that leads to coordinated Design and Construction Models. This will include:

3.3.3.1.1. Conducting BIM Kick-Off meetings, workshops and BEP updates.
3.3.3.1.2. Conducting trade coordination meetings. These meetings can be held in person or via web meetings
3.3.3.1.3. Providing actionable feedback and direction to the involved trade contractors to resolve constructability issues.
3.3.3.1.4. Ensuring technical proficiency of subcontractors to effectively participate in BIM Model
3.3.3.1.5. Participating in Princeton University tech team review meetings where Model(s) will be utilized for visualization purposes.

3.3.3.2. As-Built Model: Establishing and maintaining Construction Model to reflect changes and current conditions. Preparing of As-Built Model(s).

3.4. As-Built models
3.4.1. **Responsibilities:** The Contractor shall produce accurate As-Built Models as described in the BIM Specification. The Contractor may delegate part of the process of creating As-Built models to subcontractors but remains responsible for quality control of the model and deliverables.

3.4.2. **Process:** The Contractor will insert data fields or link to external data or digital documentation to provide for unique building element tags and building system or component identification.

3.4.2.1. **Layers:** Area/zone definition layers, created by Architect-Engineer during the design phase, shall remain in Construction and As-Built Model.

3.4.2.2. **Princeton University Property Sets:** To enable use of the As-Built model for facilities data tracking, Contractor shall insert Princeton University property sets in Component Model(s) as described in Attachment D, Process to set up property data sets in AutoCad based applications. Property sets shall identify tag number, system type and other relevant Princeton University facilities information. Data shall be input into model, or linked from model to Princeton University external data base, or other location and format determined by Princeton University.

3.4.2.3. **Building element data/information:** Contractor will insert relevant building element data such as model number, serial number, electrical requirements, etc. as outlined in maintainable items sample list attached as attachment XX. Project specific list will be provided, with Project Team support, for use during construction phase.

3.4.2.4. **Tagging:** Contractor will link tagged building element to final submittal and operational information archived in Princeton University’s collaborative system (PCS).

3.4.2.5. **Submission:** Once completed, the Contractor shall upload the model(s) for approval by Princeton University.

3.5. **Record models:**

3.5.1. **General:** In addition to record CAD files and other documentation required in Design Standards, Architect-Engineer shall submit copy of Record Model.

**Attachments**

A. **BIM Execution Plan Template**
B. Model Level of Development Matrix
C. Maintainable items sample list
D. Process to set up property data sets in AutoCAD based applications