BSR/ASHRAE Standard 224P

_____**Public Review Draft**

Standard for the Application of Building Information Modeling

First Public Review (September 2022)
(Draft shows proposed new Standard)

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at www.ashrae.org/standards-research--technology/public-review-drafts and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ANSI. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

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FOREWORD

The intended audience for this standard is the building Owner. The standard defines an approach to creating and fulfilling Building Information Modeling (BIM) requirements for a typical project from the Owner's standpoint.

Merely requiring BIM on a project does not equate to success if the Owner's goals for the project are not clearly set, and BIM requirements do not correlate to achieving those goals. BIM must be well planned and properly executed; not just BIM, but "BIM DONE RIGHT," aligning the right amount and types of resources to achieve the right results.

This standard builds on the premise that BIM, in and of itself, is not the end but rather the means to several potentially valuable project delivery outcomes for the Owner. It offers a toolset addressing three broad areas the Owner should understand in order to direct the Project Team to BIM DONE RIGHT: process, infrastructure and standards, and execution.

The Process for using BIM effectively on a project begins with defining BIM requirements in the Owner's contracts with service providers (to plan, design, construct, and operate the building) and with other stakeholders based on the project delivery method (design-bid-build, design-build, IPD, etc.). Early on, a successful BIM process includes identifying the roles and responsibilities of key project stakeholders with respect to information modeling as well as creating a BIM Project Execution Plan (BEP), an outcome-driven BIM roadmap that details how the project will be completed. Process also includes managing the project for compliance with the BEP and contract requirements, including the project deliverables.

Infrastructure and standards acknowledge the high degree of human collaboration and software interoperability needed for successful project information modeling, particularly as the project moves from phase to phase. To achieve the necessary level of interactivity, the Owner must require all members of the Project BIM Team to adhere to a framework of standards and structures from the project's onset.

Execution encompasses creating a BEP, a master plan for how information modeling will be done and managed, at the inception of a project. The BEP documents the Owner's and the Project BIM Team's mutual agreement on how, by whom, when, why, to what level, and for what project outcomes (called "BIM Uses") information modeling will be used.
While the standard highlights the essential requirements for BIM, it also offers options for Owners who wish to go beyond minimum requirements. And finally, while the standard uses the term "building" generically, in keeping with the terminology of "BIM," it is intended to apply to information modeling for the built environment; i.e., site elements and facilities as well as buildings.

1. PURPOSE

1.1 This standard provides minimum requirements for the application of Building Information Modeling (BIM) to the planning, design, construction, and operation of buildings. This standard defines how to incorporate BIM requirements in design, construction, and operations services contracts.

2. SCOPE

2.1 This standard applies to new buildings or the renovation of or additions to existing buildings using Building Information Modeling (BIM) for planning, design, construction, and operations.

3. DEFINITIONS AND SYMBOLS

(Please note that references to "model" and any related requirements refer to individual models, such as a particular discipline/trade model, as well as to composite or federated models.)

As-Built Model: the Model(s) capturing conditions at the completion of construction. It shall be initially based upon the Design Intent Model and increasingly incorporates project information as construction progresses.

Attributes: the characteristics of objects. E.g., attributes defined by a building element class may be name, length, weight, price, etc. The attribute values of a specific building element of a specific building may be Name = 'Wall-123', Length=6500.0, Weight=7300, etc. (NBIMS-US, The buildingSMART Glossary of Terms)

BIM Element Matrix: a structure that defines the elements to be modeled for each phase of the design and construction process.

BIM Project Execution Plan (BEP): the plan that results from the Building Information Modeling Project Execution Planning Procedure. The plan describes how BIM will be implemented and which goals or BIM uses will be pursued. (NBIMS-US)

BIM Use: a method of applying Building Information Modeling (BIM) during a facility's life cycle to achieve one or more specific objectives. [i] The nature of BIM technology allows different Owners to use the model in multiple ways, depending on their projects' specific needs. As the project moves from phase to phase, the information contained within the BIM grows in both quantity and specificity.

Building Information Model (BIM)/Model: the digital representation of physical and functional characteristics of a facility. As such, it serves as a shared knowledge resource for information about a facility, forming a reliable basis for decisions during its life cycle from inception onwards. (NBIMS-US)

Building Information Modeling or Management (NBIMS-US):

- Building Information Modeling: a BUSINESS PROCESS for generating and leveraging building data to design, construct, and operate the building during its lifecycle. BIM allows all stakeholders to have access to the same information at the same time through interoperability between technology platforms.
- Building Information Management: the ORGANIZATION & CONTROL of the business process by utilizing the information in the digital prototype to affect the sharing of information over the entire lifecycle of an asset. The benefits include centralized and visual communication, early exploration of options, sustainability, efficient design, integration of disciplines, site control, as built documentation, etc.– effectively developing an asset lifecycle process and model from conception to final retirement.

Classification Systems: (Reference OmniClass, MasterFormat, Uniclass, Uniformat, Others): systematic (hierarchical, networked, or faceted) arrangement of Objects or Processes in groups or categories according to established criteria within a specific domain. Problems may arise, such in AECOO - when multiple domains use classification systems without attention to harmonization of terms into a consistent and complete framework or ontology. (Merriam Webster)

Common Data Environment (CDE): (Reference ISO-19650 and CoreBIM): the single source of information used to collect, manage, and disseminate documentation, the graphical model, and non-graphical data for the whole project team (i.e., all project information whether created in a BIM environment or in a conventional data format).

Computing platform: generally and broadly applies to the computer hardware and operating systems (OS) on which computer programs or software are designed to run. The Owner shall consider current hardware and OS, and software-specific application capabilities that exist within his/her own organization and the organization of other project stakeholders—as well as future hardware and OS capabilities that are preferred or can be anticipated. Infrastructure requirements shall be considered for all project phases, from planning concept through what will `be available during the facility management and operations phase of the project. For each project phase, the Owner shall consider how information is created, stored, exchanged, secured, backed up or archived, and delivered, and whether each shall be localized, cloud- or web-based, or a hybrid.

Construction Model: the model(s) from the construction team, based on criteria that relates the design to the facility's construction process. These models are developed from the Design Intent Model during construction coordination. The files are typically combined using a cross-platform 3D model viewing software to accommodate subcontractor file formats and a higher Level of Development (LOD). This new information is reviewed by the design team for approval.

Construction Operations Building information exchange (COBie):an information exchange specification for the life-cycle capture and delivery of information needed by facility managers. COBie can be viewed in design, construction, and maintenance software as well as in simple spreadsheets. This versatility allows COBie to be used on all projects regardless of size and technological sophistication. (NBIMS-US)

Contract: as used in this standard, shall be the Contract between the Owner and the entity or entities (Architect, Engineer, Contractor, Design-Builder, Operations Provider, Maintenance Provider, Program Manager, Construction Manager, etc.), providing the contracted services (management, design, construction, operation, or maintenance) for which the Owner requires that application and use of BIM.

Contract Documents: the group of documents that define the price, conditions, clauses, schedule, and scope of the executed work, along with any other job-specific details. They can be both written and graphic, and act as a legal definition of the contract. Contract documents can include the Construction Agreement; General Conditions; Special Conditions; Scope of Work (SOW); Drawings; Specifications; Bill of Quantities; Construction Schedule; and Schedule of Values.

Data: project information that includes images, documents, CAD files, BIM files, etc.

Data Security Protocol (DSP): a definition of the security requirements for data to be implemented for the project and incorporated into the BEP.

Design Intent Model: the model(s) from the design team that captures the intended design. This model is used for project BIM Use execution, digital design mock-ups, decision support, and coordination. The approved model is a contract document for submission to the Owner and for construction handover.

GIS (Geospatial Information System): a system that creates, manages, analyzes, and maps all types of data. GIS connects data to a map integrating location data with all types of descriptive information.

Industry Foundation Class (IFC): a neutral and open specification for object-based data models developed by buildingSMART International to facilitate interoperability in the building industry. Version 2x3 is in common use for the exchange of BIM information by many BIM applications. Version 4 was released for implementation in 2013. (NBIMS-US)

Level of Development (LOD): he degree to which the element's geometry and attached information have been thought through—the degree to which Project BIM Team members may rely on the information when using the model. (NBIMS-US, AIA, BIMForum)

Defines the content and reliability of BIM elements at different stages or milestones. Content refers to geometric information, structured data, and linked documentation. Reliability refers to what uses and to what extent the downstream users of the information can trust the accuracy and quality of that content.
- LOD 100 - Concept - No geometric information in the model elements, only symbols with attached approximate information.
- LOD 200 - Design Development - The elements are generic placeholders for elements and equipment to be - They may be recognizable objects or space allocations for coordination between the disciplines.

- LOD 300 - Documentation - This level should be suitable for design intent to support processes like costing and bidding. These models will be used to generate construction documents and shop drawings. You should now be able to take measurements from the models and drawings and locations should be accurate
- LOD 350 - Defines proper cross trade coordination and will include connections and interfaces between disciplines.
- LOD 400 - Construction - This level supports detailing, fabrication and installation/ assembly. The contractor will be able to split construction requirements and assign them to subcontracts
- LOD 500 - Facilities Management - This level will have suitable geometry and information to support operations and maintenance. Geometry and data should be as-built and field verified.

Model: see Building Information Model.

Model Element: a portion of the model(s) representing a component, assembly, or construction entity (part) which, in itself or in combination with other parts, fulfills a predominating function of a construction entity.

Model Element Author (MEA): the party responsible for creating or updating any given model element.

Model View Definition (MVD): an IFC View Definition, or Model View Definition, MVD, defines a subset of the IFC schema that is needed to satisfy one or many exchange requirements of the building industry. The method used and propagated by buildingSMART to define such Exchange Requirements is the Information Delivery Manual, IDM (also ISO/DIS 29481). An IFC Model View Definition defines a legal subset of the IFC Schema (being complete) and provides implementation guidance (or implementation agreements) for the IFC concepts (classes, attributes, relationships, property sets, quantity definitions, etc.) used within this subset. It represents the software requirement specification for the implementation of an IFC interface to satisfy the exchange requirements. (NBIMS-US)

Owner: person or entity that represents and controls financial interests of a property, building, or development.

Owner's Project Requirements (OPR): Owner's written documentation of the functional requirements of the "facility" and the expectations of how it will be used and operated. They include project and design goals, budgets, limitations, schedules, owner directives, and supporting information. They include necessary information for all disciplines to properly plan, design, construct, operate, and maintain systems and assemblies. Associated with each objective or requirement in the OPR are one or more performance metrics or criteria (ASHRAE Standard 202)

Organizational Standards: Standards unique to the Owner including, the Owner's written policies, procedures, and processes. The Owner shall include Organizational Standards that define expected outcomes and deliverables in addition to those outcomes and deliverables expressed in

the OPR or this standard directly in writing in the Contract or by reference and attachment to the Contract.

Project Milestones: planning for information delivery is the responsibility of each lead appointed party and appointed party. Plans shall be formulated in response to the information requirements set out by the appointing party and shall reflect the scope of the appointment within the overall asset life cycle. Each information delivery plan should state:

- how information will meet the requirements defined in the AIR or EIR;
- when information is going to be delivered, initially with respect to project stages or asset;
- management milestones and later with respect to actual delivery dates;
- how information is going to be delivered;
- how information is going to be coordinated with information from other relevant appointed parties;
- what information is going to be delivered;
- who is going to be responsible for delivering the information; and
- who the intended recipient of the information will be.

Primary Standards: standards written by local, national, and international organizations and industry groups by consent or consensus that establish minimum levels of performance and quality and are used for comparative evaluation and verification of compliance. Primary standards are often adopted by an agency, organization, industry, or government body.

Project Data: the written and graphical information used to plan, design, construct, and operate the building. It shall include model files (BIM, CAD); drawing files (CAD; electronic sheets such as PDFs, and/or plot files); electronic manuals; tabular/textual information derived from BIM (e.g., spreadsheets); and reference files necessary to supplement other project data.

Project Life Cycle: the full development of a building project from conception to demolition, including four phases (Planning, Design, Construction, and Operations).

Project BIM Team: the people and entities involved in the definition, creation, development and maintenance of BIM work products and deliverables throughout the lifecycle of a project. Members include the Owner, architect, engineers, contractors, subcontractors, and other stakeholders. The Project BIM Team members can vary by phase; stakeholders or participants will be introduced to and leave the Project BIM Team as the project progresses through its life cycle.

Quality Assurance/Quality Control: a subset of project management that includes the actions required to ensure that the project will satisfy the needs for which it was undertaken. It consists of quality planning, quality assurance, and quality control.

Record Model: the model(s) prepared for the Owner for post design and construction Operations and Maintenance. The Design Intent Model is used as a baseline and then is updated to incorporate all the changes during construction. This is intended to be a model with enough detail to enable facilities management operations without overly detailed elements. This model may also include laser scan data. The Record Model shall contain accurate attribute data on major equipment and

systems for facilities management documented in the BEP. The Record Model typically is updated by the designer from information provided by the contractor (e.g., digital mark-ups, photography, and laser scans). It may be used during commissioning or updated to reflect commissioning data.

Technology Infrastructure: for the purposes of this standard*, technology infrastructure* is defined as the entire technology system used for a BIM project.   The use of the term *platform* in this section applies to all project-relevant computing platforms (hardware and software), including but not limited to computers, servers, network devices, backup systems, and file-sharing systems, be they resident on a local network or web/cloud based. Computing platforms are part of an Owner's and other project stakeholders' technology infrastructure, along with networks and physical workspaces.

4. PROCESS

4.1 OVERVIEW

At the project's inception, the Owner shall establish the intent and general requirements for the building. Collectively, these are known as the Owner's Project Requirements (OPR). The OPR are the Owner's written documentation of the functional requirements of the "facility" and the expectations of how it will be used and operated. The OPR shall include project and design goals, budgets, limitations, and schedules. The OPR shall also define minimum BIM requirements. OPR requirements shall be addressed in the building's "basis of design," (BOD). The building's design team shall create the BOD to define the approach and parameters for designing the building to meet the OPR. The outcome of the design phase shall be to create construction documents utilizing Building Information Modeling (BIM) in accordance with the BOD, which shall become the record of all the building's physical and functional characteristics that meet the OPR. The Owner shall consider the deliverable requirements for project data. Owners shall review their current information needs for operations and maintenance and establish data requirements that support those needs. The Owner also shall consider how BIM can support future facilities management and operations and develop requirements that support future needs as well. (Informative Note 1).

> Informative Note 1: At a minimum, major equipment shall be described by facility attributes such as make, model, manufacturer, and serial number. Additional attributes may include warranty information, parts lists, maintenance schedules, and manufacturer contact information.

4.1.1 As the project moves from phase to phase, the Level of Development (LOD) of the physical and functional characteristics (information) of the elements contained within the BIM shall be updated as to the levels indicated in Section 3 of this standard The BIM technology utilized shall support interoperability (ability for information to be exchanged and used) of the information contained within the BIM. Design and construction BIM applications shall have the capability to include or be interoperable with asset management systems, building automation and control systems, interdisciplinary coordination applications, scheduling, cost estimating systems, and integrated construction specification systems.

4.1.2 The process for applying BIM on a project shall follow these steps:

> 4.1.2.1 Minimum BIM requirements as defined in this standard shall be required by the Contract.

> 4.1.2.2 Roles and responsibilities of key project stakeholders with respect to BIM shall be defined in the Contract. These roles and responsibilities shall be further documented in the BIM Execution Plan (BEP).

> 4.1.2.3 The BIM Team shall collaboratively create a BIM Project Execution Plan (BEP) with key project stakeholders. See section 6.1 for (BEP) requirements.

4.1.3 The Owner's BIM representative shall oversee the project for compliance with the BEP and Contract requirements, including Model and Data Deliverables, through periodic reviews. Reviews shall be performed, at a minimum, at the conclusion of one phase of the project and before the beginning of the next phase of the project. For example: at the end of the Design Phase and before the beginning of Construction.

4.2 DEFINE BIM REQUIREMENTS

BIM requirements shall be defined by the Owner's overall goals, business practices, and corporate culture and are shaped by the OPR. They shall be developed on a project-by-project basis, as the Project BIM Team selects BIM Uses to achieve these requirements. The Owner shall provide any resources, such as feasibility studies and/or access to stakeholder interviews, for the Project BIM Team to define Owner-related goals. Once the Owner's project BIM goals are defined, the Project BIM Team shall also ensure that these BIM goals can be met with current technology practices and required team competencies. The project BIM goals shall lead to the choice of BIM Uses and additional BIM requirements.

4.2.1 BIM Uses and Requirements

> 4.2.1.1 The five Essential BIM Uses: Existing Conditions Modeling, Design Authoring, Design Review, Three-Dimensional (3D) Coordination, and Record Modeling shall be required as they align with the OPR. Project conditions may justify other Enhanced BIM Uses or Owner-Related Uses. The Project BIM Team shall develop the recommended BIM Uses for the project by communicating with the owner and referencing the OPR to ensure BIM uses align with Owner's project goals.

> 4.2.1.2 Once BIM Uses are determined, the LOD requirements shall be defined and documented in the BEP. The project contracts shall define responsibilities for the design and construction contracting entities, and, therefore, the LOD and division of responsibilities. Information exchange across contracting parties shall also be clearly defined and closely managed. (Informative Note 2).

Informative Note 2: There are Default LOD, Template LOD, and Custom LOD. An Owner can adopt a Default LOD that references established LOD requirements, such as the United States Army Corps of Engineers (USACE) Minimum Modeling Matrix (M3). The Owner also can use existing templates to

develop LOD requirements, such as the American Institute of Architects (AIA) G-202 BIM Protocol. It also is possible for Owners to develop a custom LOD matrix for their organization, but if they do so, they shall adhere to the LOD specification definitions. Any of these three forms of LOD specification provides a means for Owners to develop contract requirements for models and data requirements.

4.2.2 Project Delivery Method

The choice of project delivery method for the project affects the way in which the BIM is developed and how information is exchanged. A design-build (DB) project shall have at least one Project BIM Manager, while a design-bid-build (DBB) project shall have at least one BIM Manager for design and another one for construction. -   The Project BIM Manager shall be identified in the Project BEP. Refer to Section 6 for more information.

4.2.3 Intellectual Property

Intellectual property shall be defined in the Owner/designer and Owner/contractor agreements. For example, refer to the list in Informative Note 3. Any exceptions to ownership rights shall be clearly noted in the project contract(s). Ownership of project data during the course of a project and at project completion shall be addressed in the Owner/designer and Owner/contractor agreements. Owner reuse rights shall be defined in the Owner contracts. The Project BIM Team shall review this standard, the BEP, and the project contract(s) to determine governing requirements and permissions and/or limitations for ownership, conveyance, and/or reuse of data. The project contract conditions and terms take precedence over this standard, and, as with all contract documents, it is advisable to seek the advice of legal counsel. (Informative Note 4)

Informative Note 3:

Model files (BIM, CAD):
Drawing files (Electronic sheets such as PDFs, and/or plot files)

Electronic manuals

Tabular/textual information derived from BIM (e.g., spreadsheets)

Reference files necessary to supplement other project data

Informative Note 4:
Publicly funded projects are subject to the governing authority's acquisition requirements. Federally funded projects are governed per Federal Acquisition Regulation (FAR) Part 27, Patents, Data, and Copyrights.[ii]

4.3 TEAM ROLES AND RESPONSIBILITIES

4.3.1 Owner's BIM Representative(s)

The Owner shall designate an Owner's BIM Representative. The Owner's BIM Representative shall have a clear understanding of BIM and the OPR. The Owner's BIM Representative shall, at a minimum:

4.3.1.1 Represent the Owner's requirements and be able to effectively communicate them to other stakeholders.

4.3.1.2 Serve as the primary liaison between the Owner and the Project BIM Manager(s) for all BIM-related issues.

4.3.1.3 Have oversight of BIM requirements in all project phases, from planning through the construction of the project, and at least the beginning of the operations phase.

4.3.1.4 Receive, review, and approve BIM deliverables.

4.3.2 Project BIM Manager Role

The project shall have a designated Project BIM Manager for each prime contract. (Informative Note 5) The Project BIM Manager shall have sufficient BIM education and experience for the size and complexity of the project, as well as the relevant proficiency in the proposed BIM authoring and coordination software selected for use on the project. During each phase of a project, the Project BIM Manager at a minimum shall:

Informative Note 5: There may be multiple BIM Managers on a project who collaborate together; however, there shall be a lead BIM manager for the prime contract who coordinates and directs BIM managers from other consultants and trades.

4.3.2.1 Lead the process of creating and updating the BEP in accordance with the OPR.

4.3.2.2 Verify compliance of the BEP deliverables.

4.3.2.3 Coordinate all updates for individual models, specialized models, and databases.

4.3.2.4 Administer Project Quality Management and Data Security Management.

4.3.2.5 Facilitate distribution of project data.

4.3.2.6 Compile project data for review and coordination.

4.3.2.7 Facilitate design reviews.

4.3.2.8 Meet with relevant project stakeholders for review of turnover documents.

4.3.2.9 Deliver model(s) and Facility Data to Owner for use in operations.

4.3.3 Discipline/Trade BIM Manager Role

Each discipline/trade shall assign an individual to the role of BIM Manager for the duration of the project. These individuals shall have the relevant BIM experience required by the complexity of the project. The Discipline/Trade BIM Manager maintains a continuous interface with the Project BIM Manager.

The responsibilities of the Discipline/Trade BIM Manager for their respective discipline/trade include:

> 4.3.3.1 Act as the primary BIM contact for the discipline/trade.
>
> 4.3.3.2 Develop and manage exchange of models.
>
> 4.3.3.3 Maintain and manage integrity of the model.
>
> 4.3.3.4 Assume additional roles and responsibilities as defined to support the BEP and other contractual requirements.

4.3.4 Coordination

The Project BIM Team shall schedule regular BIM coordination meetings during which team members meet to discuss design and construction issues, using the model as a shared resource. The frequency of such interactions depends on the project's goals, BIM Uses, and Project BIM Team members' responsibilities as defined in the BEP.

4.4 BIM PROJECT EXECUTION PLANNING

4.4.1 The BEP is the central document for BIM implementation. This plan shall be authored by the Project BIM Team collectively, and onboarding processes shall be developed for Project BIM Team members who join the project after the initial plan has been developed.

4.4.2 The project BEP shall contain all content necessary to document the process of implementing BIM on the project. Through the BIM project planning process, the Project BIM Team shall agree on how and in what ways the Project BIM Team members will collaborate using the BIM. All project stakeholders involved with modeling shall develop and agree to a project-specific BEP. This plan shall include the requirements for information exchange among the parties, as well as for expected interactions with the model. Specific BEP content requirements can be found in Section 6.1 of this document. Specifically, the team shall develop plans and protocols to meet the OPR, including, as a minimum, file sharing and data security.

4.4.3 File Sharing Requirements

> 4.4.3.1 The file sharing requirements will vary depending on the project's BIM Uses. At a minimum, the BEP shall include a description of the:
>
> 4.4.3.1.1 File system(s) the team will use to exchange, merge, and visualize models.
>
> 4.4.3.1.2 Schedule for or frequency of model updates and clash detection checks.
>
> 4.4.3.1.3 Tools and process to be used for clash detection checking.
>
> 4.4.3.1.4 Process to be used to generate drawings from coordinated models.

4.4.4 Data Security

The BIM Team shall complete a Data Security Protocol that complies with data security requirements as defined below.

4.4.4.1 Data Security Protocol (DSP).

As part of the BEP, the Project BIM Team shall develop and submit a Data Security Protocol (DSP) to the Owner that outlines security protocols to be implemented for the project to meet the Owner's security protocols. The DSP shall be approved by the Owner prior to commencing work. At a minimum, the DSP shall address:

4.4.4.1.1 User access rights and permissions, outlining the various roles and degrees of access to the data. Roles shall correlate to those defined in this standard and the BEP. The DSP also shall identify any additional user access required.

4.4.4.1.2 Data protection, documenting how the data will be protected from:

4.4.4.1.2.1 Accidental loss.

4.4.4.1.2.2 File Corruption (malware, viruses, ransomware).

4.4.4.1.2.3 Misuse/negligence.

4.4.4.1.2.4 Unauthorized conveyance.

4.4.4.1.2.5 Deliberate attack (internal or external).

4.4.4.1.3 Data process and handling protocol procedures for:

4.4.4.1.3.1 Exchange: How and with what frequency data will be exchanged. The DSP shall align with other requirements in the BEP and provide more detail specific to digital data exchange.

4.4.4.1.3.2 Maintenance: Describe the maintenance plan for all data sources, transmission devices, and storage devices used for the project.

4.4.4.1.3.3 Backup: Describe in detail the backup scheme implemented by the Project BIM Team, including frequency and retention of backups.

4.4.4.1.3.4 Archiving: Describe the storage, retrieval, and retention system to be used by the Project BIM Team.

4.5 MANAGING PROJECT REQUIREMENTS AND DELIVERABLES

4.5.1 Quality Planning

The team shall specify roles and responsibilities for model management and quality management for the project. The BEP shall include the management strategies for implementing BIM Uses and requirements. Quality management processes shall be used to ensure BIM is created for downstream uses of the model data.

4.5.1.1 The quality standards for the modeling activities shall be discussed in detail at the early stages of the project. The following items shall be developed by the Project BIM Team prior to the start of the modeling activities:

4.5.1.1.1 A clearly defined Quality Assurance (QA) and Quality Control (QC) section within the BEP.

4.5.1.1.2 A detailed QA approach for monitoring the modeling process and is performed by the Owner or Owner's representative.

4.5.1.1.3 A detailed QC approach to test the deliverables throughout the course of the project for compliance with the quality standards.

4.5.1.2 Each QA and QC activity shall identify a Project BIM Team member specifically responsible for performing the task. The QA and QC approaches may also be incorporated into project contracts to ensure compliance.

4.5.2 Quality Assurance

Quality assurance procedures shall be defined to ensure that the Project BIM Team members are performing the modeling process defined within the BEP. The QA activities shall also be consistent with the contract. Minimum QA activities shall include:

4.5.2.1 Definition and validation of testing or prototyping process to verify the model meets the minimum modeling requirements.

4.5.2.2 Validation of resource availability and capabilities to perform modeling activities.

4.5.2.3 Review of the information exchange definitions to assure that the deliverables are clearly defined and unambiguous.

4.5.2.4 Periodic reviews of the modeling procedures to ensure that the activities being performed are consistent with the initial plan.

4.5.3 Quality Control

QC tests shall be defined to verify that the project deliverables comply with the project requirements. The Project BIM Manager shall verify that all required deliverables are submitted and appropriately distributed as defined within the BEP and any additional contractual agreements.

4.5.3.1 The following QC activities shall be performed on all project data delivered to the Owner:

4.5.3.1.1 Verification of the file or data exchange metadata as defined within the BEP to include (as appropriate for the data exchange types):

4.5.3.1.1.1 Date of submission.

4.5.3.1.1.2 File type (if file).

4.5.3.1.1.3 File name (if file).

4.5.3.1.1.4 Database access instructions (if there is database content).

4.5.3.1.1.5 General description of content.

4.5.3.1.1.6 Data schema (organization) of the file, including version, date created, and date modified by buildingSMART International (as appropriate).

4.5.3.1.1.7 Description of the data exchange standard (if an open standard).

4.5.3.1.2 Validation of the proper file type, naming convention, and appropriate software version.

4.5.3.1.3 Validation of final submitted model files (content) against the information exchange standard:

4.5.3.1.3.1 Manual validation of a specified sample of elements to verify that the information is properly structured and accurate. The sample size may vary based upon the level of criticality of the information element. The sampling procedure shall be defined within the BEP.

4.5.3.1.3.2 Visual model inspection to review general model content.

4.5.3.1.3.3 Inspection of the coordinate system to ensure that all model files have a common coordinate system.

4.5.3.1.4 Validation that model clashes have been resolved per the owners predefined minimum requirements and the criteria established within the BEP.

4.5.3.2 The tests shall be performed within an agreed-upon time before or after project milestones, as specified by the contract.

4.5.3.3 Additional QC activities shall include:

4.5.3.3.1 **Checks**: All Project BIM Team members shall check the modeling content that they receive from other team members or the Owner to verify that the exchanges contain valid field entries and the proper information elements. Project BIM Team members shall report any unusual information content.

4.5.3.3.2 **Project Data Submission Log**: The Project BIM Team shall develop and use a Project Data Submission Log, which includes model/modeling compliance issues and corrective actions. The Project BIM Manager shall review the Project Data Submission Log, participate in collaborative team resolution, and provide direction when needed.

5. INFRASTRUCTURE AND STANDARDS

5.1 TECHNOLOGY INFRASTRUCTURE

The Owner shall identify the Computing Platform for the project as the basis for the Technology Infrastructure for the project. Infrastructure requirements shall apply to all project phases, from the planning and concept phases through the facility management and operations phase of the project. For each project phase, the Owner shall identify how information is to be created, stored, exchanged, secured, backed up or archived, and delivered by the Project Team and whether each shall be localized, cloud-based or web-based, or a hybrid. The Technology Infrastructure for the project shall be documented in the BIM Project Execution Plan (BEP).

5.1.2 The Project Team shall establish and utilize a Common Data Environment (CDE) to receive, share, and provide project information and data. The CDE shall be documented in the BEP.

5.2 STANDARDS
5.2.1 Categories of Standards

5.2.1.1 Two categories of Building Information Modeling (BIM) standards: Organizational (internal) Standards and Primary (external) Standards shall be used on projects. The Organizational Standards and/or Primary Standards for BIM (or appropriate portions of them) to be used shall be cited in the scope of work (SOW) as the minimum acceptable standards when BIM is used, and BIM deliverables are required.

5.2.1.2 Areas of overlap or conflict between Organizational and Primary Standards shall be identified in the BEP. In these instances, the Project BIM Manager shall determine, in consultation with the Owner and other stakeholders, which document will take precedence or whether amendments are required.

5.2.2 Owner-Specified Guidelines and Standards

Organizational Standards and OPRs or other owner-specific requirements that reference these standards or modify them shall be used in conjunction with this standard. For dated references, only the edition cited applies. For undated references, the latest edition (including any amendments) applies.

5.2.2.1 Space and graphical standards for drawings required by the owner shall be complied within models. Any exceptions shall be documented in the BEP.

5.3 FILE STRUCTURE

Project data shall have well-defined project file naming and folder organization standards. The folder structure shall meet the requirements established in the Organizational Standards if provided with any variances documented in the BEP. If the Organizational Standards for file naming and folder organization do not exist, these shall be defined in the BEP. The project file sharing system shall have the high-level branches of the folder structure pre-populated in the system prior to the bid phase or at the earliest possible stage of the project.

5.3.1 Since record documents will be distributed through the folder system, the project folder organization shall align with the division of responsibilities of the stakeholders. It is beneficial to establish a file permission strategy on the shared folder system, where only appropriate organizations in the project have write permissions within their assigned folders, and the remainder of the team has read-only permission. At the highest level, the folder system shall be controlled by the project administration.

5.3.2 File naming conventions are needed to establish coherency of project documentation and simplify high level understanding of the file contents. The file naming system shall identify a set of data fields to be contained in the file name. A typical file standard shall establish a clear order on file name attributes with a reserved delimiter such as an underscore (_) to identify the divisions between fields. The project shall comply with any Owner-Specified Requirements or shall meet all the following requirements.   Regardless of the requirements used, the naming conventions shall be consistent.

5.3.3 Folder Naming

Folder names shall be numbered or alphabetized to control order. Folder names shall be clear indicators as to what the folder contains (e.g., a folder for Models could be named *07_ Models*).

5.3.4 File Naming

File names shall contain a discipline designator (such as "A" for Architectural) as defined in the National CAD Standard (NCS). Custom naming schema shall be clearly documented in the BEP.

> 5.3.4.1 Sheet file names, regardless of file format, shall comply with NCS. At a minimum, they shall include the sheet number.

> 5.3.4.2 Model file names shall contain discipline designator within the name, as outlined in the NCS.

5.3.5 Component Naming Conventions

The naming conventions used for systems, elements, objects, components, and parameters shall be documented in the BEP or referenced from an appropriate standard.

5.3.6 File Sharing

A model sharing system shall be employed. If the Owner does not designate a system, then the Project BIM Manager shall provide a model sharing system for the sharing of individual and merged models. The model sharing system shall include:

> 5.3.6.1 Project BIM Team access, including real-time access and synchronization of models.
> 5.3.6.2 Automated versioning of models.
> 5.3.6.3 Data security.
> 5.3.6.4 Maintenance and archiving of the previous model versions.
> 5.3.6.5 Permission-based access for each team member to upload their models.

5.3.7 Transmittal Requirements

At a minimum, all deliverables of data, documents, and files shall include the following information as applicable per media type:

> 5.3.7.1 Project title.
> 5.3.7.2 Project location.
> 5.3.7.3 Contract number.
> 5.3.7.4 Designer(s) of record and/or contactor(s) (general or sub).
> 5.3.7.5 Classifications for the data (i.e., sensitive, classified, etc.).

5.3.7.6 Contents of the transmittal, including date created, date modified, version, etc.

5.3.7.7 Author and/or responsible individual.

5.3.7.8 Recipient(s).

5.3.8 Any additional information required by the Owner or identified in the BEP shall be included.

5.4 MODEL STRUCTURE

5.4.1 Model structure defines the highest level of decomposition (breakdown into component parts) of the digital model(s). Model structure shall align with the Owner's Project Requirements (OPR) and selected BIM Uses, as defined in the current version of NBIMS™.

5.4.2 If, for technological limitations or work share requirements, the model shall be decomposed to a structure below a single building, then each model shall be clearly denoted as a portion of a building, and one composite model per building shall be provided for each deliverable.   A holistic composite model is necessary, even if the composite model is only used as a container for links and/or references (i.e., a means of packaging all related files for delivery).

5.4.3 The model structure shall be clearly defined in the BEP.

5.5 MODEL REQUIREMENTS

5.5.1 The Owner shall develop or adopt/adapt well-defined contract requirements to ensure the project model data requirements are met. The OPR shall address model requirements such as modeling responsibility, the modeling process, minimum model contents, facility data to be captured, and Level of Development (LOD).

5.5.2 Project stakeholders' modeling responsibilities shall be clearly defined within the BEP. Each model element shall be assigned to a Model Element Author (MEA) and a corresponding LOD for the element clearly defined; consequently, each MEA is required to provide the elements at the LOD specified in the BEP or a corresponding LOD worksheet. Each MEA is responsible for attaching any data or metadata to the model elements as required by the contract, BEP, or as needed to facilitate the project's selected BIM Uses.

5.5.3 Modeling Process

5.5.3.1 The modeling process and responsibilities shall include:

5.5.3.1.1 Use of a standardized classification system organized according to NBIMS-US™ Section 2.5: OmniClass Table 21 Elements.

5.5.3.1.2 Use of IFC-compliant software (within one version of the latest certification available).

5.5.3.1.3 Use of BIM software that can meet the OPR per project-specific selected BIM uses.

5.5.3.1.4 Use of the appropriate tool(s) within the BIM software selected to create or document the building element being represented.

5.5.3.1.5 The model(s) shall be updated with any revisions required to meet the deliverables defined in the OPR at each project milestone as documented in the BEP. Any deviations from OPR shall be documented in the BEP.

5.5.3.2 The Project BIM Team shall document the choice of platform in the BEP.

5.5.3.3 Project BIM Team members shall use BIM application(s) and software(s) to develop and document the project. Design professionals shall create the Design Intent Model(s) and use them to produce accurate construction documents. Construction professionals shall use the Design Intent Model(s) and the construction documents as a starting point for developing the Construction Phase Model(s). The As-Built Model facilitates the update of the Design Intent Model(s) into a Record Model. The roles and responsibilities for the development of the As-Built Model and Record Model shall be defined in the BEP.

5.5.4 Model Contents

5.5.4.1 Models shall include all content necessary to meet the OPR requirements. Models and corresponding elements or sub-elements shall be modeled as defined in the project Model Development Specification. The Model Development Specification shall be documented in the BEP.

5.5.5 Project Data

5.5.5.1 The Project BIM Team shall develop Project Data for all elements that make up the model. This Project Data shall include all material definitions and attributes that are necessary for the project planning, design, construction, maintenance, and operations phases as defined in the OPR. All elements shall be assigned a classification and category to meet the OPR.

5.5.6 Development Specification.

5.5.6.1 The Model Development Specifications shall define the desired LOD for model elements that meet the project's specific organizational and project goals. Default LOD: If the Owner elects to reference an existing LOD without making modifications, the relevant source definitions must be integrated into the BEP to ensure requirements are available to all.

5.5.6.2 If the Owner elects to develop his/her own LOD Matrices identifying LOD and model element authors for models or model elements, owners shall ensure that custom definitions are recorded in the BEP.

6.0 EXECUTION

6.1 BIM PROJECT EXECUTION PLAN (BEP)

6.1.1 The BEP shall be created in the early stages of a project and focus on the decisions required to define the scope of Building Information Modeling (BIM) implementation on the project, identify process impacts of using BIM, define the team characteristics needed to achieve the modeling, and quantify the value proposition for the appropriate level of modeling at the various stages in the project life cycle.

6.1.2 Development of the BEP

6.1.2.1 The BEP shall be considered a living document that evolves throughout the project. The BEP shall be developed and refined by the Project BIM Team to document the collaborative process of how BIM will be executed throughout the project life cycle.

6.1.2.2 The initial version of the BEP shall be developed by the Project BIM Manager, assisted by the Owner and the Project BIM Team (as referenced in NBIMS-US™ V3, Section 5.4), to detail the BIM requirements for the project. It shall be submitted for approval to the Owner.

6.1.2.3 The BEP shall be refined by the entire Project BIM Team as the project progresses. When a new Project BIM Team member is added to the project, the Owner shall develop the collaborative BEP and coordinate with the new member.

6.1.2.4 The BEP shall be reviewed and coordinated with the entire Project BIM Team prior to construction and submitted to the Owner for final approval. The BEP shall be reviewed with specialty contractors prior to execution of their contracts. Any revisions to the BEP shall be submitted to the Owner for final approval.

6.1.2.5 The Project BIM Team shall use the BEP template in the NBIMS-US™ V3, Section 5.4: BIM BEP Content, which identifies the minimum BIM requirements to develop an acceptable BEP. The BEP shall specify how different versions of the model will be stored and retrieved as the project progresses.

6.1.2.6 Where the BIM is to be used for design/documentation and then for construction, the BEP shall address model information exchange procedures, i.e., how the BIM can migrate between project phases effectively with minimum effort. First, the Project BIM Team members shall coordinate the BIM Uses they seek to leverage when they determine the model exchange procedures. For example, model coordination would require a high degree of geometric accuracy for the design model. Once BIM Uses are identified, the team shall decide who is developing which models, and when these models are exchanged. The BEP shall be used to organize responsibilities and modeling requirements.

6.2 BIM USES

6.2.1 BIM Use Overview

The nature of BIM technology allows different Owners and other stakeholders to use the model in multiple ways, depending on their projects' specific needs. As the project moves from phase to phase, the information contained within the BIM grows in both quantity and specificity.

6.2.1.1 BIM Uses shall be considered and aligned with project goals, selected based on added value to the Owner, and clearly documented in the BEP. The BEP is intended to apply to information modeling for the built environment: site elements and facilities as well as buildings. Required BIM uses for the project shall be identified in the OPR or statement of work. How these BIM uses are implemented on the project shall be documented in the BEP. Allowable BIM uses shall be those identified in the latest NBIMS.

6.3 BIM DELIVERABLES

6.3.1 The BEP shall clearly define the deliverables that are to be transmitted to the owner at the completion of any defined project milestones. The model requirements for each deliverable shall be clearly defined within the contract documents for each responsible party. Model contents shall be identified in the BEP. The Project BIM Team shall provide deliverables in compliance with the phases described in the BEP. At each phase, the Project BIM Team shall provide a written report confirming that consistency checks, as identified in the Quality Management section of the BEP, have been completed. This report shall be discussed as part of the review process and shall address any identified interferences and constructability issues.

6.3.2 The following sections provide a description of potential deliverables.

6.3.2.1 Design Intent Model.

6.3.2.2 Construction Model.

6.3.2.3 As-Built Model.

6.3.2.4 Record Model.

6.3.2.5 A report generated from the model of all assets and attributes.

6.3.2.6 A report verifying the model/modeling compliance with Owner Project Data exchange requirements.

6.3.2.7 A report verifying the accuracy of the delivered model elements and asset attributes.

6.3.2.8 An interference (clash detection) check report.

6.3.2.9 A list of all submitted files. The list shall include a description, directory, and file name for each file submitted. Identify files that have been produced from the submitted model and Project Data.

6.3.3 Operations and Maintenance Data: This deliverable includes asset inventory with asset name, classification, and location. Owners shall consider operations and maintenance data deliverables to include attributes such as make, model, and serial number of key components.

The Project BIM Team should provide the Owner with the following, as identified in the BEP:

6.3.3.1 Updated BIM PxP.

6.3.3.2 2-D drawing deliverables printed directly from the model in PDF format. Documents are to be stamped and signed in traditional practice to comply with the Owner's Design and Construction Standards and local permitting requests.

6.3.3.3 Construction Model(s) per discipline.

6.3.3.4 A 3-D interactive review format of the model in the latest version of software, as required in the BEP. The file format for reviews can change between submittals.

6.3.3.5 Construction Submittals. All construction submittals, requests for interpretation (RFIs), and change order requests (CORs) should make use of the model for clear interpretations.

6.3.3.6 Record model(s).

6.3.3.7 A report generated from the model of all assets and attributes.

6.3.3.8 A report verifying the model/modeling compliance with Owner Project Data exchange requirements.

6.3.3.9 A report verifying the accuracy of the delivered model elements and asset attributes.

6.3.3.10 An interference (clash detection) check report.

6.3.3.11 A list of all submitted files. The list should include a description, directory, and file name for each file submitted. Identify files that have been produced from the submitted model and Project Data.

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