HAS BIM Standards

Date: July 20,2017

Contents

1   Abbreviations

AIA	American Institute of Architects
AHU	Air Handling Unit
AOA	Air Operations Area
APM	Automated People Mover
ASIS	HAS Airport Spatial Information System
ATS	Automatic Transfer Switches
AV	Audiovisual
BHS	Baggage Handling System
BMPs	Best Management Practices
BPxP	BIM Project Execution Plan
BMMS	Base Map Management System
BIM	Building Information Modeling
CIM	Civil Information Modeling
CMAR	Construction Manager at Risk
DB	Design-Build Contractor
EAMS	Enterprise Asset Management System
FAA	Federal Aviation Administration
FFE	Furniture, Fixture and Equipment
GIS	Geographic Information Systems
GSE	Gate Support Equipment
HVAC	Heating, Ventilation, and Air Conditioning
HAS	Houston Airport System
I-BIM	Infrastructure BIM
ICT	Information and Communications
IFC	Interchangeable Foundation Class
LoD	Level of Development
MSE	Mechanically Stabilized Earth
O&M	Operation and Maintenance
PBB	Passenger Boarding Bridge
PMT	Program Management Team
QA/QC	Quality Assurance/Quality Control
SWPPP	Stormwater Pollution Prevention Plan
VFD	Variable Frequency Drives

2   About This Handbook

2.1   Introduction

Building Information Modeling (BIM) is a process which can provide value to the Houston Airport System (HAS) programs and projects, supporting coordination and collaboration from the earliest stages from planning to commissioning and Operation and Maintenance (O&M). Whether by validating the accuracy of design data or facilitating the exchange of information, BIM can be used to provide an enhanced understanding of design integration and how assets will function over their lifecycle.

2.2   Purpose

The purpose of this document is to implement BIM technology efficiently during projects administered by HAS. It describes the expectations, requirements, and standards related to BIM including roles, responsibilities, and procedures for stakeholders participating in an HAS program or project.

2.3   Scope

HAS BIM Standards are defined as documented criteria for production and delivery of BIM within a program or project servicing the HAS.

For a comprehensive view of HAS BIM-related Standards and Procedures, other documentation must be referenced. The Program Management Team (PMT) internal BIM Procedures documents BIM processes, while the program or project specific procedures are documented in a BIM Project Execution Plan (BPxP). The HAS BPxP template is the basis of the BPxP and includes documentation of external BIM Procedures with the PMT, Design Consultant and Contractor.

This document contains expectations for all HAS BIM projects including:

- The HAS BIM vision
- BIM uses within a project
- BIM procedures that support specific BIM uses
- Modeling requirements
- Collaboration requirements
- HAS BIM Execution Plan procedures
- BIM deliverable requirements
- Quality Assurance/Quality Control (QA/QC) requirements
- Reference standards

3   Definitions

BIM

Building information modeling (BIM) is a process involving the generation and management of digital representations of physical and functional characteristics of places. BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during the facility life-cycle, from earliest conception to demolition. BIM may be categorized as follows:

- BIM: Building Information Modeling
- CIM: Civil Information Modeling
- I-BIM: Infrastructure BIM

For the purpose of this document, BIM may refer to BIM, I-BIM and CIM, where appropriate.

BIM Manager

The BIM Manager is defined as the lead point of contact to manage project BIM issues for each contracted project representative. For the purpose of this document, the BIM Manager is further defined as follows:

- Program Management Team (PMT) BIM Manager: Leads BIM implementation and oversees BIM application to the program.
- Design Consultant BIM Manager: Leads BIM implementation and oversight for the Design Consultant.
- Contractor BIM Manager: Leads BIM implementation and oversight for the Contractor, which may be defined as the Construction Manager at Risk (CMAR) or Design-Build Contractor, depending on project delivery method.

Model(s), BIM Model(s)

Building information models are files (often but not always in proprietary formats and containing proprietary data) which can be extracted, exchanged or networked to support decision-making regarding a building or other built asset. Current BIM software is used by individuals, businesses and government agencies who plan, design, construct, operate and maintain diverse physical infrastructures, such as water, wastewater, electricity, gas, refuse and communication utilities, roads, bridges, ports, tunnels, etc.[1]

For the purpose of this document, BIM Model(s) are further categorized into the following:

- Design Model(s): Created and developed by the Design Consultant in order to develop the project design.

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[1] https://en.wikipedia.org/wiki/Building_information_modeling

- Construction Model(s): Created by the Contractor from the Design Model in order to develop and fulfill construction requirements.
- As-Built Model(s): Prepared by the Contractor to show on-site changes to the original Construction Models.
- Record Model(s): Prepared by the Design Consultant from the Design Model and that reflects on-site changes that the Contractor noted in the As-Built Models.

4   HAS BIM Vision and Objectives

HAS includes various departments/stakeholders throughout the organization that can benefit from BIM during design, construction, project closeout and activation. These groups will need different sets of information and will also use the information in unique ways. Because of the various needs, one objective of this Standard is to clarify each group's expectations, use case, and specific format requirements. This will enable the project design and construction teams and all BIM stakeholders to prepare for and deliver information to HAS in an efficient manner with a usable format.

The following is a list of HAS BIM objectives by function:

Planning
BIM may be used for:

- Space Planning and Analysis
- Geographic Information Systems (GIS) data input management

Business and Property Management
- Tenant / Leasing contracts

Asset Management
BIM data will be integrated into HAS's Facilities Enterprise Asset Management System (EAMS) for use in the following:

- Preventative maintenance
- Corrective maintenance
- Scheduled inspections

Finance and Procurement
BIM may be used for:

- Pay application justification
- Change Order clarification

Security
BIM may be used for:

- Spatial location and "views" of all cameras and security access readers
- Inventory and mapping of security equipment

GIS

BIM may be used for:

- Spatial location and information of infrastructure assets
- Integration with the OnBase digital document management system
- Assimilation into enterprise GIS Airport Spatial Information System (ASIS)

4.1   Integrated Approach

HAS advocates this integrated approach to project delivery. This integrates people, systems, and practices to optimize efficiency through all phases of design, fabrication and construction.

This integrated approach encourages early contribution of knowledge and experience while requiring proactive involvement of key stakeholders from conception throughout the facility's life cycle.

5   BIM Uses

HAS expects that BIM processes be implemented on all projects to the broadest extent possible. The extent and details of BIM use on a specific project are to be determined and documented within the BPxP. Potential BIM uses include:

- Record Modeling
- Asset Management
- Space Management
- 3D Control and Planning
- 4D Control and Planning
- Site Utilization Planning
- Design Authoring
- Design Reviews
- Code Validation
- Building Systems Analysis
- Building Sustainability
- Building Performance Analysis
- Programming
- Site Analysis
- Cost Estimation
- Existing Conditions Modeling

6   BIM Procedures

In order for BIM uses to be implemented effectively, BIM procedures are to be developed and documented for each BIM use. Specific details, roles and responsibilities shall be defined within the BPxP. These procedures can be grouped in the following manner.

6.1   BIM Management Level Procedures

- Collaboration
- BIM-related Meetings
- Model Delivery Schedule of Information Exchange for Submission and Approval
- Electronic Communication
- Governing of Project BIM Execution Plan
- Model Archiving

6.2   BIM Production Level Procedures

- Existing Conditions Modeling
- Cost Estimation
- Construction Sequencing (4D Modeling)
- Programming
- Site Analysis
- Design Reviews
- Design Authoring
- Energy Analysis
- Structural Analysis
- Lighting Analysis
- 3D Coordination
- Site Utilization Planning
- 3D Control and Planning
- Record Modeling
- Maintenance Scheduling
- Building Systems Analysis

6.3   Other BIM related Procedures

- Design Quality Control
- Construction Quality Control
- Design/Construction Clarifications
- Requests for Substitutions
- Differing Site Conditions
- Standards and Codes Compliance

7   BIM Best Practice Workflows

BIM Best Practice workflows are Standard Operating Procedures which facilitate delivery of BIM in order to meet the expectations and requirements of HAS. While these are general best practices, there may be variations in these practices based on the specifics of a given project.

Discipline

These workflows describe best practices for interdisciplinary collaboration in Revit, from the Design Consultant's perspective.

The Design Consultant's Architectural Group will start a project by creating the Levels and Grid(s). The group will then create their model, which might contain Structural elements. Once the design is progressed to the appropriate milestone and/or Level of Development, the Architectural Group will share their Model with the Structural Group.

The Structural Group will link the Architectural Model (origin to origin). The group will determine the Structural elements by making changes to the Levels and Grid based on the Architectural Design, as appropriate. Once the design is progressed to an appropriate milestone and/or Level of Development, the Structural Group will share their Model with the Architectural Group.

The Architectural Group will link the Structural Model and will monitor the Structural Levels, Grids and Structural elements, and remove instances of the Levels, Grid and Structural elements they originally created and are now being driven by the Structural Group. The Architectural Group will continue their design effort by adding architectural elements intended as placeholders. Once the design is progressed to an appropriate milestone and/or Level of Development, the Architectural Group will share their Model with the Electrical and Mechanical Groups.

The Electrical Group will link the Architectural and Structural Models (origin to origin) and Copy/Monitor at a minimum, the Structural Levels and Grid and the Architectural Walls if needed. The Electrical Group will start their design effort by laying out their Corrosion Protection, Electrical and/or Electronics components based on the placeholders determined by the Architectural Group. Once the design is progressed to an appropriate milestone and/or Level of Development, the Electrical Group will share their Model with the Team.

The Mechanical Group will link the Architectural and Structural Models (origin to origin) and Copy/Monitor the Structural Levels and Grids and the Architectural Walls if needed. The Mechanical Group will start their design effort by laying their Fire Protection, HVAC and Plumbing components based on the placeholders determined by the Architectural Group. Once the design is progressed to an appropriate milestone and/or Level of Development, the Mechanical Group will share their Model with the other groups.

The Architectural Group will link the Electrical and Mechanical Models and remove any preliminary locations of Lighting and Plumbing Fixtures originally placed during the start of design.

Site

A Revit Site Model file should be created for the project. This Site Model will contain shared coordinates information derived from Civil3D CAD Files using HAS Base Map Management System (BMMS) information. This file relates the project coordinate system to HAS GIS and controls the location, rotation, and elevation of all Revit-based Models (Architectural, Electrical, Mechanical and Structural) for the project. Revit Shared Coordinates should only be acquired from (or published from) this model. Each individual discipline or building model must be able to be linked into the Site Model by Shared Coordinates.

Facility Information

A Facility Information Model file stores the latest and most current version of the Revit Project and the HAS required Facility Information. The HAS Shared Parameters and other HAS data requirements must be incorporated into this Revit Model for use with the HAS Enterprise Asset Management System (EAMS) solution. Specific delivery requirements for the Facility Information Model are detailed in the BIM Project Execution Plan.

8   Model Requirements

In general, the scope of work is to create a technically accurate and highly detailed BIM/3D computer model to include the following systems as appropriate to the project: architectural, structural, IT/ communications, facility management, security, lighting, signage, mechanical (HVAC), electrical, plumbing, fire protection, fire alarm, passenger boarding bridges (PBBs), and baggage handling system (BHS).

This section establishes the technical criteria required to develop a project using BIM technology for HAS.

8.1   General Requirements

All BIM Models shall be developed in accordance with the most current version of the HAS BIM Standards and should be compatible with the current approved version of Revit-based applications currently in use by HAS, regardless of when the project Notice to Proceed for design services was executed.

The following proposed elements are minimum requirements; content may be revised as required by the project.

- Model all perimeter site fencing with required security access points and delivery entrances.
- Model all major stormwater pollution prevention plan (SWPPP) elements including silt fencing, wash racks, and best management practices (BMPs) locations.
- Model all major material and man lifting equipment (cranes, man lifts, fixed concrete pump stations, etc.) and proposed envelope of influence (radius of swing, total height, major picking stations, etc.).
- Model all temporary and permanent shoring, and areas of excavation including affected lay back areas, with appropriate sloped surfaces.
- Model all proposed material lay down areas
- Model all temporary office and trailer locations

- Model all temporary roadways required for potential phasing including but not limited to: perimeter barriers (jersey barriers, k-rails), paving surface relocations, storm drainage requirements, snow storage areas, and first-responders site and perimeter access roadways.
- Model "no-fly zones" surrounding temporary and/or permanent fire hydrant locations.
- Model proposed "evacuation areas".
- Model onsite temporary parking locations.
- Model all phase revisions to temporary pedestrian covered walkways and/or clearance zones.
- Revit elements shall have correct and schedulable UNIFORMAT numbering.

Extent of Model

The building computer model (in plan view) shall typically extend to five (5) feet beyond the exterior walls of the building(s) being modeled. Vertically, the model shall extend from the lowest extent of the foundations or lowest underground utility up through (and including) the roof of the top-most floor, or highest overhead utility or adjacent structure. To the extent that the scope includes building systems, those systems will be included to the full horizontal and vertical extents of the model including underground utilities and roof-top mounted items.

Model scope also includes relevant faces/masses of buildings and encroachment zones (FAA Part 7460) adjacent or across street. Existing conditions will be modeled at level 300 (see Model Progression Specification – LoD Matrix) when directly adjacent to new construction. Otherwise, existing conditions shall be modeled as masses.

Model Granularity

This document assumes that not all items will be modeled within the BIM Model files. This is a common practice supported by HAS BIM Standards, and therefore, the Design Model itself may not represent the exact actual elements that are installed. Two exceptions are:

- The objects with a significant impact on cost estimates, which should be modeled with proper estimation parameters included.
- The objects crucial for operation of the building, which should be modeled with proper parameters associated.

Each model element as a minimum shall include the following parameters:

- HAS relevant parameters (defined in the HAS Shared Parameters File)
- UNIFORMAT identifier, applied correctly to the element
- Cost parameters
- HAS specified view and sheet filtering parameters

Model Level of Development

The Model Level of Development (LoD) describes the level of completeness to which a specific system within a model is developed for a given project. The Level of Development is accumulative and should progress over the course of the project. The HAS Level of Development is based on the AIA – Exhibit E202 Document and its attachments. HAS uses the current BIM Forum Level of Development Specification as the reference definitive document and may make some changes in the definitions per project. These changes will be reflected in BPxP.

Model Quality

All BIM Models shall be developed using object-based elements only, such as Columns, Beams, Walls, Doors, Windows, etc. along with their associated parametric information. Generic solid or plane based modeling requires a specific written exception.

Model Discrepancies

When conflicts exist between the contents of a BIM Model and the Construction Documents, the information contained within the Contract Set will prevail and be considered as definitive.

HAS Model Ownership

HAS holds ownership of the BIM Model. This includes, but is not limited to, Revit families (system-based and/or component-based) and any other content submitted as part of the BIM Model itself.

8.2   Special Construction

Special construction includes airport special systems such as Automated People Movers (APMs), Baggage Handling Systems (BHS), Passenger Boarding Bridges (PBBs), and Information and Communications Technology (ICT) solutions, among other specialty systems. Special construction will be determined after Schematic Design.

8.3   Model Requirements for Existing Conditions

Laser Scanning

High definition laser scanning and existing conditions surveying will be conducted for the buildings and rooms adjacent to the project boundary. Responsibility for laser scanning may be determined in a separate contract, but it will be the responsibility of the Design Consultant to validate the existing rooms adjacent to the project boundary to confirm occupancy, use, furniture, fixtures and equipment (FFE), and internal service utilities. Areas of the existing building are to be translated to a Revit model for coordination and made available to the Design Consultant and Contractor teams.

8.4   Model Requirements for Design Phase

The level of detail as defined in each section below is the minimum level of detail required in the model. Refer also to the Project BIM Execution Plan for modeling requirements in relationship to each phase of the project. Any further model development or scope deemed necessary and not previously defined will be addressed as they are identified. The Design Consultant and Contractor will determine the effect on the

model(s) and scope, and propose the appropriate response to accommodate the noted model development and/or coordination issue.

Architectural

The following stipulations will be used for architectural model elements.

- All exterior walls, doors, windows, steps, railings and roofs will be modeled.
- All interior walls, including non-rated walls separating rooms, will be modeled.
- Risers and sloped floors will be modeled.
- Interior doors and windows will be modeled to the extent that the walls they are associated with are included in the model. King studs and headers shall be modeled as part of the wall adjacent to the window or door family.
- All interior ceilings, soffits, stairs, and railings will be modeled.
- Walls, ceilings, and soffits will be modeled as the overall thickness including elevation changes and termination points. Overall thickness is to be determined by their actual total composite assemblies.
- Doors, window leaves, and frames will be modeled
- The overall extent of stairs and loading docks will be modeled including railings; intermediate railing members do not have to be modeled.
- Light fixtures will be modeled to the overall height, width, depth and access through the interstitial space.
- Elevator shaft clear space will be modeled to the worst case clear width, depth and height only from preferred possible vendors; elevator cabs, equipment, etc. will not be modeled. Nominal elevator cab size and overrun shall be modeled including the hoist beam.
- Escalators and moving sidewalks shall be modeled to the worst case clear width, depth and height only from preferred possible vendors.
- Signage shall be limited to wayfinding and room Identification required by code.
- Fixed furnishings including systems furniture will be modeled. Equipment will be modeled. Casework, including upper and lower cabinets will be modeled. Carpet, paint, wall coverings, tile, wall base and trim carpentry will not be modeled.

Structural

The following stipulations will be used for structural model elements.

- All cast-in-place concrete, including all penetrations and openings identified in the Construction Documents, will be modeled. Slab camber will not be modeled. Chamfers at corners will not be modeled (but will be detailed).
- Edges of all slabs and penetrations of structural systems will be accurately located in the model.
- All primary and secondary structural steel members will be modeled, including standard steel member sizes, gusset plates, braces, kickers and equipment supports. Reinforcing steel and imbeds will not be modeled.
- Metal, wood and concrete decks will be modeled as the overall thickness of the slab; ribs in metal decks will not be modeled.

- Bolts, clip angles, etc. will not be modeled.
- Miscellaneous metals such as elevator hoist beams, rails and intermediate rail support steel for the elevator will be modeled.
- Identify reinforcing or penetration "no-fly zones" as applicable.

HVAC

The following stipulations will be used for Heating, Ventilation, and Air Conditioning (HVAC) model elements.

- All ducts and air handling equipment will be modeled. Ducts will be modeled to the outside face dimension of the flanges/insulation. Duct joints do not have to be modeled, but all hangers will be modeled to ensure conflicts are reduced.
- Equipment will be modeled to its overall height, width and depth. Equipment access zones will be modeled as solids.
- Any piping associated with the mechanical equipment will be modeled. Pipes will be modeled to the outside diameter of the pipe or pipe insulation (whichever is greater).
- Any electrical associated with HVAC will be modeled per the electrical modeling requirements as outlined in the Electrical Section.
- The intent of this model is to show the ductwork and piping, etc. in as true a representation as possible of the actual condition at construction completion. Specific dimensional location of ductwork and piping may not be included in the construction documents. To the extent that location can be determined from the construction documents, the model will reflect that location.
- Identify "no-fly zones" with solid transparent (50%) placeholder clearance object for: access issues, code issues, and/or constructability.

Electrical

The following stipulations will be used for electrical model elements.

- Conduits 4-inches or greater or, smaller conduits if in ganged runs will be modeled.
- Ganged runs shall be modeled.
- Cable tray, access zones, and equipment to be included in the model.
- Light fixture locations and space requirements to be included in the model.
- All power feeds to equipment and all switchgear will be modeled.
- Consider modeling switches and outlets where coordination with architectural FFE or interior elevations is a concern.
- Any access zones requirements will be modeled as solids.
- "No-fly zones" above electrical panels shall be modeled as solids.

Plumbing

The following stipulations will be used for plumbing model elements.

- Piping 2-inches or greater or smaller piping if in ganged runs will be modeled.

- Plumbing piping and gas piping, including specialty gas, and equipment will be modeled. Pipes will be modeled to the outside diameter of the pipe or the pipe insulation, whichever is greater.
- Pipe slope will be incorporated in the model.
- All plumbing equipment will be modeled to its overall height, width and depth.
- All valves and clean outs will be modeled along with all access to valves/cleanouts.
- Any access zone requirements will be modeled as solids.

Fire Protection (Sprinkler and Alarm)

The following stipulations will be used for fire protection model components.

- All components 2-inches or greater of the fire protection system will be modeled. This includes all piping, valves, fire pump, and sprinkler heads.
- Any access zone requirements will be modeled as solids.
- "No-fly zones" above control panels shall be modeled as solids.
- Fire alarm modeling requirements shall follow the requirements of the Electrical section.

Vertical Transportation

To be determined based on Project specifics. Elevator clear shaft space requirements are included in the architectural scope.

Civil/Site

- Utilities within the project boundary of the footprint are to be modeled in three dimensions and accurately represented with family elements. The Civil/Site model may be modeled in *Civil3D*.
- Utility trench excavation surfaces.
- Excavation lift models of proposed daily progress of mass excavation and utility trenches.
- Shored walls/surfaces.
- Mechanically Stabilized Earth (MSE) walls.
- Bridge soffit surfaces – Pre-camber and post-camber.
- Bridge bents.
- Bridge top deck surfaces – Pre-camber and post-camber.
- Bridge hinge keys.
- Electrolier bases on bridges.
- Bridge barriers.
- Piping / Conduit / Duct banks: Model all proposed installations including but not limited too; piping, joints, sump basins, storage tanks, and free draining material wraps or bedding around piping. Pipe networks "part properties" shall be populated with relevant geometric and analytic data pertaining to; "Geometry, Resize Behavior, Hydraulic Properties, and Part Data".
- Excavation and vertical underground elements: Model all temporary and permanent shoring, and areas of excavation including affected lay back areas, with appropriate sloped surfaces.
- Horizontal site development: Model all temporary roadways required for potential phasing including but not limited to: perimeter barriers (jersey barriers, k-rails), paving surface relocations,

storm drainage requirements, snow storage areas, and first-responders site and perimeter access roadways.

- Site areas of impact: Provide model elements to indicate areas of influence. Sterile area boundaries, Air Operations Area (AOA) boundaries, or stakeholder access zones.
- Civil 3D deliverable files should be accompanied by a LandXML 1.2 file of alignments /profiles / surfaces and points, and an Interchangeable Foundation Class (IFC) format if possible.

Baggage Handling System (BHS):

- The BHS shall be modeled in 3D and provide the clear area and dimensions of equipment. Model equipment to suitable level of detail to ensure the required clear space for the baggage envelope, egress and other right-of-ways are maintained throughout the system.
- Equipment will be modeled to its overall height, width and depth, including motors.
- Model the required clear space for the baggage envelope as solid above the bag line surface.
- Any access zone (work areas for pulling motors) requirements will be modeled as solids i.e. clearances in front of motor control centers.
- Model the preliminary support structure for the BHS; Floor, wall or ceiling mounted supports.
- Model any catwalks necessary for the BHS.
- Coordinate clear width and height egress paths.
- Coordinate all floor and wall openings, concrete curbs, and security/fire doors required for the BHS.
- "No-fly zones" above control panels shall be modeled as solids.

Security and IT Systems

- Electrical/wiring associated with Security and IT Systems are to be modeled per the electrical modeling requirements as outlined in the Electrical Section.
- At a minimum, device locations are to be designated by installation points in 3D space.
- Equipment and server racks are to be modeled as solid objects to their overall height, width, and depth.
- "No-fly zones" above control panels shall be modeled as solids.

8.5   Model Requirements for the Construction Phase

The level of detail defined in each section below is the minimum level of detail required in the model. Greater detail than the minimum should be incorporated only when it provides value. Refer also to the Project BIM Execution Plan for modeling requirements in relationship to each phase of the project. Any further model development or scope deemed necessary and not previously defined will be addressed as they are identified. The Contractor will determine the effect on the model(s) and scope, propose the appropriate response to accommodate the noted model development and/or coordination issue.

Civil / Site

Proposed Civil / Site elements below are the minimum required and shall be modeled to the "Level of Detail" as represented by the "Model Progression Specification":

- Piping / Conduit / Duct banks: Model all proposed installations including but not limited too; piping, joints, valves, catch basins, valve boxes, pull boxes, sump basins, tanks, trench bedding, encasements, and free draining material wraps or bedding around installations.
- Excavation and vertical underground elements: Model all temporary and permanent shoring, and areas of excavation including affected lay back areas, with appropriate sloped surfaces.
- Horizontal site development: Model all temporary roadways required for potential phasing including but not limited to: perimeter barriers (jersey barriers, k-rails), paving surface relocations, storm drainage requirements, snow storage areas, and first responder's site and perimeter access roadways.
- Site areas of impact: Provide model elements to indicate areas of influence. Model all phase revisions for required Ground Support Equipment (GSE) routes, critical delivery points, sterile area boundaries, AOA boundaries, or stakeholder access zones.

Steel

The fabrication level detailed model shall include, but is not limited to, major structural members, secondary structural members, and miscellaneous steel connections including:
- Trusses
- Beams
- Columns
- Gusset plates
- Bracing
- Angles
- Knife plates
- Edges of all slabs and penetrations of structural systems will be accurately located in the model.
- Other elements necessary for the successful coordination of other building trades
- Kickers and equipment supports
- Miscellaneous metals such as elevator hoist beams, rails and intermediate rail support steel for the elevator will be modeled.

Heating, Ventilation, and Air Conditioning (HVAC)
- Model All ductwork to be shown as actual duct size, in the correct location in 3D space
- External insulation on piping and ductwork must be modeled to scale, internal insulated duct is to be noted.
- Model all air devices including: grilles, registers, louvers and diffusers.
- Model all fire and smoke dampers and indicate service access requirement (i.e. access panel) if not readily accessible.
- Identify duct balance dampers and model service access requirements as solid objects.
- Model coil pull areas.
- Model duct hangers, supports and seismic bracing carrying two (2) or more ducts.

- Model all Mechanical Equipment: Fans, Air Handling Units (AHUs), Built-Up AHUs, pumps, tanks, valves, controls, heat exchangers, valves (including valve stems and handles), gauges and control valves, high and low point drains, and starters, etc.
- The HVAC Contractor shall also include in the 3D model concrete equipment pads, inertia pads and access doors.
- The HVAC Contractor shall identify under separate drawing layer access doors and accessibility requirements for above listed items for code and maintenance purposes.

Plumbing
- Model all piping 1-inch and larger including insulated piping with insulation outside diameter at 1-inch and greater.
- Model all valves, gauges, and control valves and service access.
- Model pipe hangers, supports and seismic bracing carrying two (2) or more pipes.
- External insulation on piping must be modeled to scale.
- Model all drip legs, drain pipes, blow down valves, and cleanouts
- Model all underground piping.
- Model all Plumbing Equipment: Domestic Water, Chilled Water, Steam, Storm/Roof Leaders, pumps, tanks, water heaters, in wall carriers, in wall plumbing equipment, etc.
- The Plumbing Contractor shall also include in the 3D model concrete equipment pads, inertia pads and access doors.
- The Plumbing Contractor shall identify under separate drawing layer Access doors and Accessibility requirements for above listed items for code and maintenance purposes.

Fire Protection
- Model all Fire Protection Equipment: Pre-action System, Dry System, and Main Fire Protection Systems, Hangers and Seismic Bracing, Valve Assemblies, Drain valves, Fire Department Valves, Fire Pump etc.
- Model all sprinkler head locations and sprinkler head types.
- Model any tanks not included in the architectural or structural Models.
- Model all fittings, drains and test connections.
- Model "No-fly zones" above control panels shall be modeled as solids.
- The Fire Protection Contractor shall also include in the 3D model concrete equipment pads, inertia pads and access doors.
- The Fire Protection Contractor shall identify under separate drawing layer access doors and accessibility requirements for above listed items for code and maintenance purposes.

High and Low Voltage Electrical
- Model all conduit raceways 1-inch and larger.
- Model all grouped conduit raceways with two (2) or more conduits.
- Model all junction boxes 6-inches x 6-inches and larger.
- Model all cable trays and / or hook locations.

- Model hangers, supports and seismic bracing.
- Model all light fixtures (including neon) and switching devices.
- Model door security Jammer Bars
- Model all fire alarm devices
- Model phone/data ports
- Model all security devices (cameras, card readers, motion sensors, auto door locks, etc.)
- Model all audio speakers and equipment.
- Model all Electrical Equipment: panels, transformers, switch/paralleling gear, Automatic Transfer Switches (ATSs), generators, data racks, starters, Variable Frequency Drives (VFDs), exit signs, Audiovisual(AV) Equipment, recessed electrical devices and access doors, etc.
- The Electrical Contractor shall also include in the 3D model equipment pads, inertia pads, and access doors
- The Electrical Contractor shall identify under separate drawing layer access doors and accessibility requirements for above listed items for code and maintenance purposes.

Controls (Facilities Management System)
- Model all panels.
- Model individual conduits 1-inch and larger, racks carrying more than two (2) conduits 1-inch and smaller.
- Model hangers, supports and seismic bracing.
- Model all controls equipment: panels, transformers, controls, cable tray, data racks, starters, VFDs, etc.
- The Facilities Management System Contractor shall also include in the 3D model concrete equipment pads, inertia pads and access doors.
- The Controls Contractor shall identify under separate drawing layer, access doors and accessibility requirements for above listed items for maintenance purposes.

9   Deliverables

9.1   General Overview
At regular predetermined intervals throughout the design and construction phases, HAS will require the Design Consultant and Contractor to submit individual BIM, Federated BIM, drawings and other documents as contract deliverables. These deliverables are complements to the typical 2D deliverable usually expected from the Design Consultant and Contractor at each regular project milestone or phase. The format and details of deliverables will be determined by the BIM Project Execution Plan.

9.2   Model Accuracy and Tolerances
The following tolerances generally apply to elements that require Level of Development (LoD) 300 or higher. More details shall be defined within the LoD.

PHASE	DISCIPLINE	TOLERANCE
Existing Conditions Model	Civil, Utilities (Underground)	Accurate To +/- (6-inches) of Actual Size
Existing Conditions Model (Accessible Items)	Architectural, Structural MEP+FP	Accurate To +/- (1/8-inches) Of Design Intent Size
Design Document Models	Civil, Architectural, Structural, MEP+FP	Accurate To +/- (1/8-inches) Of Design Intent Size
Shop Drawings Models	Civil, Interiors, Envelope, Structural MEP+FP	Accurate To +/- (1/16-inches) Of Actual Size
As-Built Models	Interiors Not Related To Code	Accurate To +/- (1/8-inches) Of Actual Size
As-Built Models	Interiors Related To Code	Accurate To +/- (1/8-inches) Of Actual Size

9.3   HAS Shared Parameters File

As a minimum requirement for the HAS Shared Parameters File, the BIM model shall contain all HAS-required parameters accurately and comprehensively and readily available for delivery to the EAMS solution at the time of Record Model delivery. More details will be defined within BIM Project Execution Plan.

10   BIM Project Execution Plan (BPxP)

HAS requires that a BPxP be created for each project. The BPxP shall be adapted to support the contract delivery method and specifically outline BIM protocols, workflow and role responsibilities of each party.

To develop the BPxP, a BIM planning team should be assembled within 30 days of Notice to Proceed for Design Services. This team should consist of representatives from all the primary project team members including HAS, PMT, Design Consultant, Contractors, and major specialty contractors. It is very important for HAS as well as all primary team members to fully support the planning process. For the initial goal-setting meetings, key decision-makers should be represented from each of the organizations so that the overall goals and vision for implementation of the project are clearly defined for further planning initiatives. Once this initial goal-setting is complete, then the detailed implementation processes and information exchanges can be developed and implemented by the lead BIM coordinators for each of the parties.

The BIM Execution Plan shall include the following as a minimum:

A. BPxP Overview

B. Project Information

C. Key Project Contacts

D. Project Goals / BIM Uses

E. Organizational Roles / Staffing

F. BIM Process Design

G. BIM Information Exchanges

H. BIM and Facility Data Requirements

I. Collaboration Procedures

J. Quality Control

K. Technological Infrastructure Needs

L. Model Structure

M. Project Deliverables

N. Delivery Strategy / Contract

O. BPxP Change Management

10.1 HAS BPxP Template

HAS developed a template document for the BPxP. This template document is the baseline document and will be modified and further developed to a Project BIM Execution Plan during BIM planning meetings.

10.2 Planning Meetings

The planning team should conduct a series of planning meetings to develop the Project BPxP based on the HAS BPxP Template document. On most projects, a minimum of three (3) meetings will be needed to develop the overall BPxP. The initial meeting will need representation from key decision makers for all organizations. Follow-up meetings will require fewer people and will be more focused on the details related to execution.

10.3 BIM Execution Plan Governing Process

BPxP Change Management

Any regular change in the BPxP will follow these procedures:

A. Regular meetings on the BPxP will be held every other month.

B. Before the meeting, all parties will prepare documents proposing changes within the BPxP. HAS, Design Consultant and Contractor will send their list of changes to the other parties no later than ten (10) days before the date of the meeting. PMT BIM manager prepares the meeting agenda no later than seven (7) days before the date of the meeting and transmits the agenda to the other parties.

C. Meeting minutes containing approved BPxP changes will be prepared by the PMT BIM Manager and be published to the other parties. The PMT BIM Manager then updates the BPxP accordingly.

D. The BPxP has a revision number. Tagging and re-visioning will be per the HAS Document Management Software.

Incidental changes requested by the Design Consultant or Contractor follows these procedures:

A. Change requester will issue a document addressing the change(s) and the reason(s) for that change.

B. If the request is not critical, the PMT BIM Manager applies the change into the BPxP and publishes the versioned document to all parties. Otherwise, the PMT BIM Manager requests a meeting to discuss the change.

C. The meeting will held no later than seven (7) days after the request. The change requestor documents the results into meeting minutes and PMT BIM Manager updates the BPxP accordingly.

D. Documentation and workflows will be executed within the HAS Document Management Software.

10.4 BIM Issue Resolve Process

BIM issues and clash avoidance sessions are ongoing during design and construction. The Design Consultant and Contractor shall participate in regularly scheduled internal BIM issue resolve or clash avoidance meetings. However, there are certain situations when resolving specific BIM issues depends on decision-making from the PMT. In such cases, upon initializing an issue, the initiator (either Contractor or Design Consultant BIM Manager) will send a notification through document management software to the PMT BIM Manager with attachments describing the issue and reason for meeting. Upon receipt, the PMT BIM Manager will arrange a session within seven (7) days that includes the PMT BIM Manager, Contractor BIM Manager and Design Consultant BIM Manager as participants. The issue initiator will generate a report documenting session results, and will distribute the report through the HAS document management software.

The issues that have potential for a change order or fall into an RFI process are beyond this scope and shall be addressed through the change management procedure.

11 Standards and Codes Compliance

HAS BIM Standards

A. Model shall satisfy minimum BIM standards as:

1. buildingSMART alliance NBIMS-US™ Current Version

HAS Other Standards

A. Model should address all HAS standards. Minimum applicable HAS standards are:

1. Design Manual

2. IAH Surveyor's Handbook Part 1

3. IAH Surveyor's Handbook Part 2

4. HOU Surveyor's Handbook

5. EFD Surveyor's Handbook

6. CAD/Geospatial Data Standards

7. Plan's Cover Sheet

Complete list of applicable standards will be defined in Project BIM Execution Plan.

11.1 Checking Model against HAS Standards

The HAS/PMT BIM group will require access to current production BIM models at regular intervals in order to monitor progress and compliance. The frequency and details of these exchanges will be defined in the BPxP.

The PMT BIM group will perform does regular and incidental model checks against the HAS BIM Standards. These checks will confirm:

A. If HAS specific parameters are correctly applied to every correspondent entity;

B. If Models comply with HAS CAD standards;

C. If Models comply with HAS Graphic Standards;

D. If Models comply with current BPxP demands.