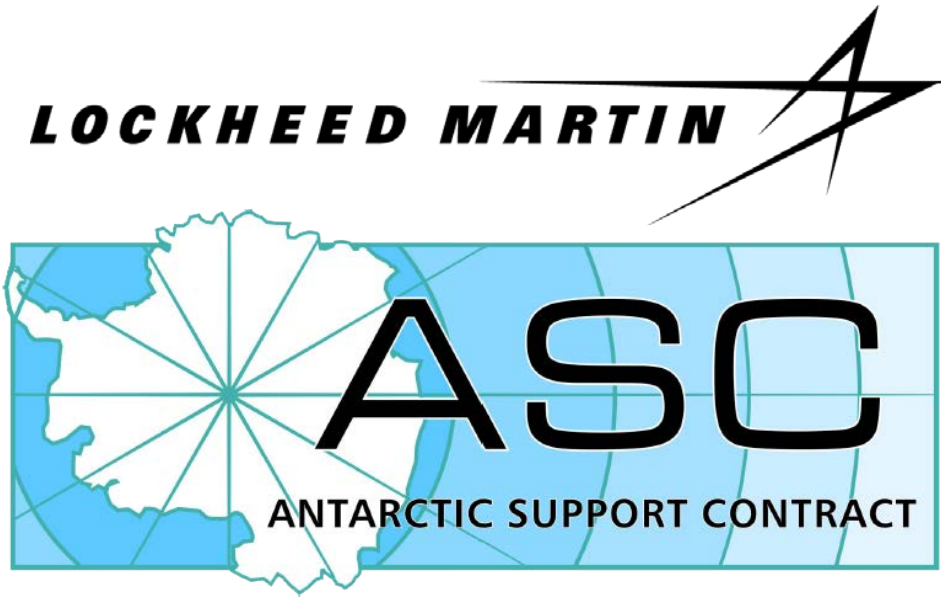

BUILDING INFORMATION MODELING STANDARD

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Revisions

VERSION	DATE	SECTIONS	AUTHOR	CHANGE DETAILS
A	01/22/2016	All	CH2M Hill	40% Draft
B	02/16/2016	All	CH2M Hill	80% Draft
C	02/26/2016	All	CH2M Hill	95% Draft
D	03/04/2016	All	CH2M Hill	98% Draft for Final Comments
E	03/11/2016	All	CH2M Hill	100% Draft for Formatting
0	03/21/2016	All	CH2M Hill	Issued

Contents

Executive Summary

Prologue

Building Information Modeling (BIM) is an intelligent 3-dimensional model-based business process that provides the United States Antarctic Program (USAP) with the opportunity to make quantum improvements in the way it plans, designs, constructs, and manages buildings and infrastructure. This document provides BIM implementation instructions for internal and external parties. Accompanying these written instructions are technical standards that provide the basis for creation of models. The technical components consist of templates, libraries, shared parameter files and similar content.

This Standard was created by joining the USAP vision with the practical knowledge and industry experience of renowned BIM experts. Architect and Engineering (AE) firms with whom the USAP routinely works also provided indispensable input during the development of the document. The Standard will be updated, over time, to incorporate lessons learned, best practices and new requirements.

Key Document Elements

1. The purpose of this document is to communicate USAP requirements for implementing and managing BIM for design and construction projects.
2. The intent of this Standard is to define the deliverables required, not to specify exact processes for each project or to identify a delivery method - except as it relates to producing standardized models and data.
3. The USAP Vision for BIM is to use the models and associated data developed during design and construction to maintain and operate buildings. This Vision drives requirements within the Standard including Level of Development, data collection, standardization, and other technical requirements.
4. Since models and associated datasets will be developed by multiple sources over an extended period of time, this Standard was created to ensure consistency across the entire project portfolio. Compliance with this Standard is mandatory when executing BIM for the USAP unless formal relief is provided from specific requirements.
5. The Standard consists of this written document and the associated Revit and Civil3D Templates, Libraries, and Shared Parameter files.
6. It is expected that all Subcontractors initiate a dialogue with the USAP during BIM planning to discuss any desired project-specific deviations to the Standard. These requests will be considered by the USAP as long as the deliverables still meet the spirit of the document. Project-specific BIM Execution Plans are the mechanism for negotiating and documenting these waivers or deviations.
7. Projects are required to design in the Model using compliant software, as opposed to designing in another environment and importing the results into the Model. This does not preclude the use of other software to conduct analysis or other tasking that is more appropriately executed in a different environment. Such variant software use shall be documented in BIM Execution Plans.
8. Delivered Models will include geometry as well as appropriate data elements as specified herein.
9. The BIMs will contain all appropriately detailed elements and information at a level sufficient to produce any Documents for Design, Shop Drawings for Construction, and Schedules and Data Sets.
10. Both the BIMs and 2D Deliverables are considered contract requirements. 2D documents for both design review as well as construction are to be extracted directly from the BIMs where possible.

BIM Terminology

The terms below are derived from typical industry usage and are provided to eliminate confusion as well as to reinforce a common language for team members executing BIM for the USAP. See also section 2.5, Roles and Responsibilities.

The **Design Model** is the production model (e.g. Revit, *.rvt) that captures the design intent of a given portion of the design, usually a specific discipline (e.g. Architectural, Structural, Mechanical, etc.). Each Design Model is created by Architect and Engineering team members for their specific area of expertise, and sometimes for a specific area of the facility or building. In the industry these are sometimes referred to as **Work-in-Progress (WIP)** models. 2D documents are created from the Design Models and reviewed at predetermined project milestones during Design Review Meetings. All the models are eventually federated (combined) into the Container or official Design Intent Model which provides a full 3D and data representation of the project.

The **Container Model** is an empty file to which all Design Models are connected for holistic design review or data extraction. In the industry this is sometimes referred to as the federated **Design Intent Model**. It includes all necessary information to convey the intention of the design, including size and shape of features, tolerances, manufacturing processes, relationship between features, dimensions, and the use of equations. This model is used to execute project-specific BIM Uses, most frequently for 3D modeling and clash avoidance. The approved version of the Design Intent Model is the final version created by the AE firm, which is a contract document for submission to the USAP and for eventual handover to the construction firm. Construction documents are derived from the approved Design Intent Model.

The Design/WIP Models and Container/Design Intent Models are project deliverables.

Construction / Shop / Fabrication Models are developed from the Design Intent Model during construction coordination and are typically reviewed and approved by the design team to ensure compliance with the Design Intent Model. These models are used for fabrication of construction materials or assemblies.

As-Built Models typically include information from shop models and drawings produced by trades and fabricators that are updated to reflect as-installed conditions. This model may also include laser scan data. It is used as a detailed reference document of all as-built conditions and informs the Record model with as-built conditions. This model is submitted by the GC to the USAP.

The **Record Model** is the Design Intent Model updated to show the as-built locations of the elements within this model. The Record Model is the basis for FM handover and does not reflect all as-built components' geometry. For example, the Record Model will have the major elements of the MEP system, but may not show the hangers. The Record Model will contain accurate attribute data on major equipment and systems for Facilities Maintenance (FM) documented in the BIMxP. The Record Model is typically updated by the Designer from information provided by the GC (digital mark-ups, photography, laser scans). It may be used by Commissioning or updated to reflect Commissioning data. This is a contract document submitted to the USAP.

Abbreviations

The following abbreviations are used in the document. Some common terms have special significance in this document.

AE	Architectural and Engineering firm
AHU	Air Handling Unit
ASC	Antarctic Support Contract
bSa	Building Smart Alliance (https://www.nibs.org/?page=bsa)
BIM	Building Information Model/Modeling
BIMxP	BIM Execution Plan
BOM	Bill of Materials (e.g. quantity take-off)
COTS	Commercial Off-The-Shelf, typically referring to software
DB	Design-Build, a contract delivery method
DBB	Design-Bid-Build, a contract delivery method
GC	General Contractor
LIDAR	Technology that creates 3D point-cloud representations of as-built facilities or infrastructure (https://en.wikipedia.org/wiki/Lidar/). Note there are different opinions of what the acronym stands for.
LOD	Level of Development (http://bimforum.org/lod/)
MEP	Mechanical, Electrical, Plumbing
NSF	National Science Foundation
PSU	Penn State University
SME	Subject Matter Expert
STANDARD	This BIM Standard document
USAP	United States Antarctic Program
WIP	Work in Progress Model

SECTION 1

Introduction

This section provides the background and motives for developing this document.

1.1 General

Building Information Modeling (BIM) is a business process involving the generation and management of information that can be used to design, construct, operate and maintain buildings and supporting infrastructure. It typically involves the creation of 3D digital representations – models – depicting physical and functional characteristics of places. Teams use these BIMs not only to visualize and share their work in progress, but also as a tool to simulate construction and project-related logistics. It is a risk mitigation tool that helps the owner and others communicate as well as more fully understand intentions and impacts prior to executing any work in the field. Collaborating in this manner provides the opportunity to identify and correct errors prior to construction, to optimize logistics staging and construction phasing, and to identify other efficiency opportunities. The United States Antarctic Program (USAP) embraces this approach to managing and executing construction projects.

1.2 Purpose

This BIM Standard defines requirements, provides specifications and guidelines, and establishes a common language for design and construction teams to use when working on capital projects for the USAP. Both Architect and Engineering firms (AEs) and General Contractors (GCs) will use this Standard to develop a unique BIM Execution Plan for every project. The intent of this Standard is to define the deliverables required, not to specify exact processes for each project or to identify a delivery method. It also establishes the framework to enable the USAP to manage project teams in order to deliver consistent BIM models with standard geometry and data for operational use at project turnover.

The USAP capital project team envisions using BIM as well as the appropriate simulation and integration tools to manage team collaboration and to efficiently integrate designs produced by each firm as they mature. This type of design process and the related tools are currently not used by the USAP. Data integrity, systems integration, and accessibility are critical factors that will impact the effectiveness of modeling and team collaboration. Proper requirements gathering and related planning to ensure effective deployment of BIM for USAP projects is essential for successful use of information during design, construction,

USAP BIM VISION

Building Information Modeling (BIM) is an intelligent model-based business process that provides the United States Antarctic Program (USAP) with the opportunity to make quantum improvements in the way it plans, designs, constructs, and manages buildings and infrastructure. Using BIM, the USAP will optimize the entire lifecycle of facilities management to deliver safe, efficient, and world-class science facilities in Antarctica.

The USAP will capitalize on BIM's ability to fully capture and transfer data from Design through Construction to Operations and Maintenance in order to use interoperable building information models and supporting technology to inform all facility management business decisions. Use of a common model that is transferred between BIM Owners through the entire design-construction process is envisioned, when practical, to minimize rework.

and the lifetime of the building.

1.3 Strategy

The USAP's goal is to digitally represent facilities and other designated infrastructure assets (such as utilities) in 3D models with accompanying standardized datasets, all residing in a centralized facilities management portfolio. This portfolio will be developed by implementing projects approved through the Capital Plan, augmented by subsequent facilities modifications executed through routine operations and maintenance activities. Ultimate integration between the facilities portfolio and other systems such as our Computerized Maintenance Management Systems (e.g. Maximo) is desired to ensure data integrity and synchronization between systems and to streamline related work activities.

Models and associated datasets forming the portfolio will be developed by multiple sources over an extended period of time. Portfolio standardization will be achieved by mandating compliance to a set of USAP-specific BIM Standards and Requirements. Project teams will be required to develop a compliant BIM Execution Plan for each specific capital improvement project. This process will deliver model integrity and data consistency across the portfolio and ensure that the portfolio serves as the master

GUIDING PRINCIPLES

1. Create an environment in which virtual design and construction techniques can be implemented to expose and correct defects early in the project lifecycle, thereby minimizing remedial actions during construction.
2. Leverage industry experience and best practices, tailoring processes and employing appropriate tools for USAP-specific needs.
3. Utilize BIM and related technology to optimize existing business practices in order to enhance project execution and improve service delivery.
4. Introduce BIM through small, less complicated projects and progress to larger, more complex ones over time.
5. Ensure early and frequent engagement between the project team and end users such as operations and maintenance.
6. Define end state operational environment and functionality (e.g. system interfaces such as BIM to Maximo) to identify precursor data capture requirements and system integration activities.
7. Ensure that project-specific BIM business decisions are appropriate to scale and that they support overall progression toward the desired end state operational environment.
8. Implement proven commercial off-the-shelf (COTS) technology solutions to provide required functionality and that comply with programmatic constraints.
9. Stay abreast of software developments and advances in industry best practices and lessons learned in order to modify BIM execution when justified.
10. Employ BIM-specific contractual language to increase probability of delivery of products and services.
11. Integrate existing structures unaffected by the Capital Plan into the BIM portfolio using 2D to 3D conversion, LIDAR, or other appropriate methods.

information repository for facilities management.

1.4 Expectations

The Antarctic Support Contract (ASC) works in partnership with the National Science Foundation (NSF) to deliver high quality services not only to the government but also scientists and others who execute projects or related work. AEs and GCs awarded work by ASC are expected to work in a collaborative manner with everyone involved in the project delivery to execute in the most efficient and cost effective manner.

All BIMs are to be the center of design and the source of most construction documents; therefore, they should not be developed after design and/or construction is complete as a separate, independent exercise. If field inspection indicates that a deviation from the model is warranted for safety, efficiency, operability or another justifiable reason, the GC will submit a proposed model change to ASC. The change will be explored and analyzed with all team members in order to determine the appropriate course of action. If the change is approved the model will be adjusted and the work executed. If not, the project will proceed as originally designed.

ASC recognizes that BIM and related technology will continue to evolve. This document is the initial version of a standard that provides the necessary instructions to AEs and GCs for successful execution of projects in Antarctica. It will be reviewed periodically and updated as necessary to capture industry best practices.

1.5 Document Overview

This Standard was created by joining the USAP vision with the practical knowledge and industry experience of renowned BIM experts. Architect and Engineering firms with whom the USAP routinely works also provided indispensable input during the development of the document. The Standard will be updated, over time, to incorporate lessons learned, best practices and new requirements.

This document outlines the USAP's BIM project expectations centering on the BIM, its creation, management and maintenance, as well as current and future leveraging of uses. The remainder of this document provides both administrative direction as well as technical guidance to ensure that those working in BIM on behalf of the USAP know the standards when producing deliverables. Information is organized as follows:

- Administration – describes Compliance, Change Management, Roles and Responsibilities and similar
- Planning – includes activities that need to be completed before model design begins
- Production – identifies software and provides model management guidance
- Coordination and Collaboration – describes expectations for working together and communicating
- Uses – lists different ways to use the models, technical requirements, and processes
- Quality – defines QC expectations of others as well as specifying USAP QC metrics
- Deliverables – lists what others provide to the USAP and when
- Operations – provides a forward-looking view that describes options for achieving the USAP vision of utilizing the model for operations and maintenance

This Standard is the high-level BIM document from which others flow. The individual project BIMxPs developed by various BIM Owners should ensure information and requirements are not duplicated, and are not in conflict[1].

[1] See section 2.5 for Roles and Responsibilities, specifically BIM Owners.

SECTION 2

BIM Standard Administration

This section covers the administration of the standard through the life of the program.

2.1 Ownership

The USAP BIM Standard is managed by the BIM Program Manager (see section 2.5.1). All questions, requests for interpretations, and suggestions for changes shall be submitted directly to the BIM Program Manager, who will coordinate the decision-making process and communicate with AEs, GCs and other appropriate parties.

2.2 Compliance

The BIM Program Manager is responsible for reviewing BIM submissions, determining compliance, and enforcing any necessary corrective actions. Compliance will be judged against geometry, data, and BIM deliverable requirements as detailed in this document. The BIM Program Manager can approve or reject any submission and require the BIM Owner to resubmit, and has the ability to enforce compliance as with any other aspect of the project.

It is important to note that compliance with the Standard must not be confused with compliance with design criteria or building codes.

2.3 Change

Changes to the Standard are expected. The need for changes may come from the NSF, AEs, GCs, or from within the USAP. Any person working on the USAP program, at any level, can identify a need for a change. Suggestions for change must be communicated clearly to the BIM Program Manager, who will vet the suggestion through a process that involves careful discussion, prioritization, implementation, and communication to all appropriate parties.

Some changes may be enhancements that take advantage of innovative ideas or new technologies. It is understood and expected that the USAP BIM program will develop over time, becoming increasingly more powerful and technically advanced. Other changes may be corrections that are required in order to make current systems work or to meet overall goals. It is understood that the USAP BIM program may need this kind of careful refinement.

It is critical that all changes be identified and managed for the benefit of the overall program, and to ensure eventual operational BIM goals are reached. Therefore, while there may be a desire to fix things locally (and quickly) on a specific project and report them later to the BIM Program Manager, this tendency must be suppressed in favor of timely reporting and subsequent resolution in the context of, and for the benefit of, the entire USAP program.

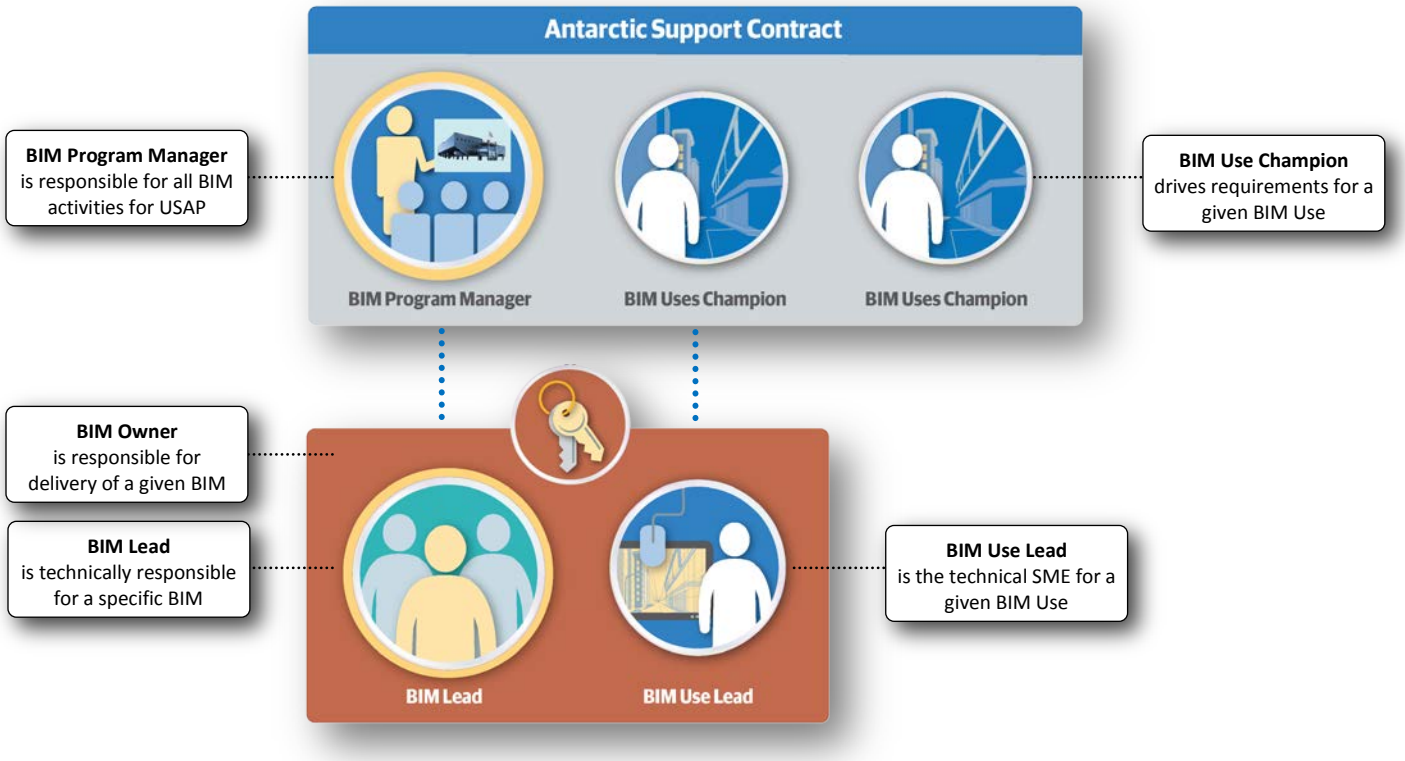
2.4 Support

The BIM Program Manager will provide support to all entities performing BIM work, as they work to comply with the Standard. Support may take the form of training, coaching, technical support (answering questions), fielding change requests, etc. It may also be in the form of specific technical delivery of content and materials.

It is expected that each USAP design and/or construction project will conduct separate BIM Coordination meetings (weekly or as agreed).

2.5 Roles and Responsibilities

This section identifies the various entities involved in BIM activities, and establishes clearly defined areas



of responsibility.

These roles are typically fulfilled by existing project team members and should not require special augmentation or hiring dedicated staff to execute the work.

2.5.1 BIM Program Manager

The BIM Program Manager is the ASC person responsible for all BIM-related activities for the program.

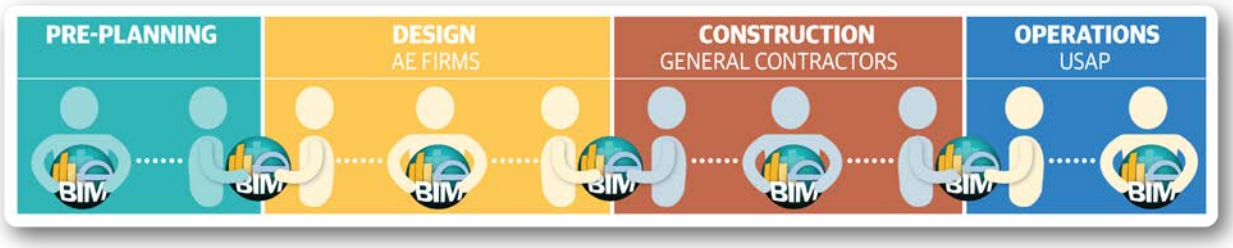
The BIM Program Manager:

- Is responsible for BIM standards development, maintenance, and compliance
- Fields questions from the AEs and GCs, and provides answers and support

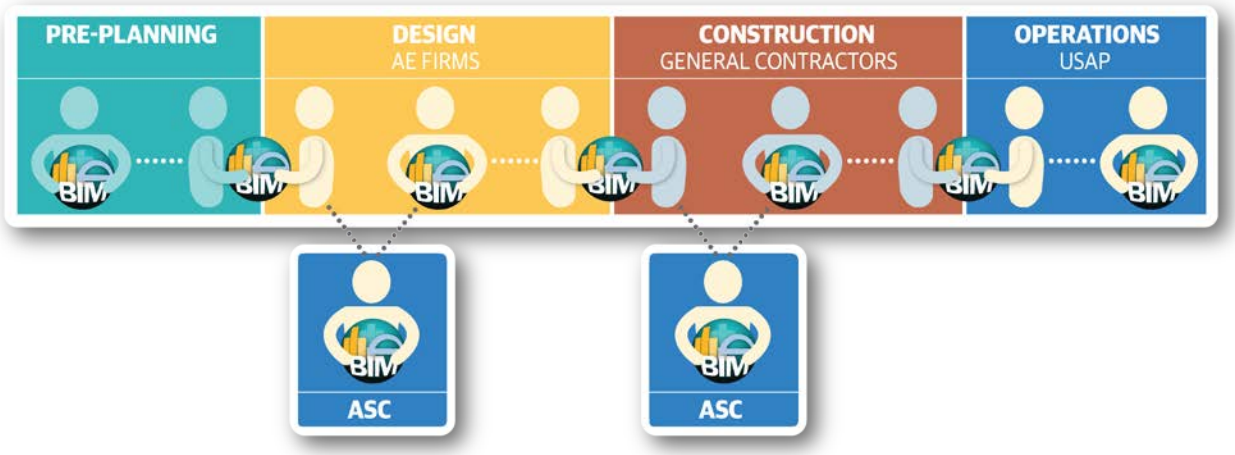
2.5.2 BIM Owner

The BIM Owner is the party responsible for effective and timely delivery of a given BIM, following standards and supporting BIM Uses, at a given point in time. There can only be one BIM Owner at any time for each BIM. During different phases of any specific project, the AE, GC, and the USAP may all be BIM Owners.

The BIM Owner can be a design or construction firm, in any given delivery process (DBB or DB). The BIM Owner may change throughout the program. For example, a design firm will own the model at first, then ownership may pass to the construction firm, then ownership will be passed on to the ASC facility maintenance and operations group.



If there is a holding period or delay between design and construction, or between phases of design,



ownership will be passed from the AE to the USAP for safekeeping during that period.

The BIM Owner develops and/or maintains the BIM while ensuring compliance with this Standard. Additional specific duties depend on the phase of design and construction, and are discussed in other sections of this document.

2.5.3 BIM Lead

The BIM Lead is the technical point person within a given BIM Owner's organization – the AE or GC – who is identified and tasked specifically with maintenance of a specific BIM within the USAP program.

Each BIM Lead:

- Must have the appropriate level of experience with BIM processes, collaboration and data sharing, and the software being employed for the specific project being executed
- Is responsible for the data integrity of their model(s) as well as compliant data transfer to project team members requiring their BIM model and related data sets, including all BIM-related data and model transfers to consultants and trade contractors.

Each consultant or trade contractor engaged by a GC and involved in BIM processes shall also designate a BIM Lead to interact with their prime contractor. The prime contractor is responsible for training the consultant or trade contractor BIM Lead to ensure deliverables comply with the requirements of the project-specific BIM Execution Plan.

2.5.4 BIM Uses Champions

The BIM Use Champions are ASC individuals who provide guidance and input for the successful execution of BIM Uses. These are not technical BIM experts but rather subject matter experts in various areas of the ASC program, such as Energy Analysis or Scheduling. Each Champion can be thought of as the client of a given BIM Use, who can leverage the BIM to provide value to their work.

Each BIM Use Champion:

- Defines the goals, purpose and desired outcome of a given BIM Use
- Ensures completeness and accuracy of the BIM Use description and requirements in section 6 of this document
- Coordinates with Project Managers in order to partner directly with the BIM Use Lead for a given BIM Use
- Establishes and prioritizes BIM Use requirements, and helps to explain them as needed
- Supports the overall BIM efforts by providing answers, information, and other services within their professional domain

The BIM Use Champion is similar to the senior engineer in a given design discipline, such as Mechanical HVAC. Where the BIM Use Lead is responsible for the successful technical execution of generating discipline-specific schedules and drawings (BIM Use Drawing Generation), the Champion decides what properties must be in the schedule, how the schedule should be formatted, and what the drawings should look like.

Using the Energy Analysis as an example, the Champion would:

- Explain why Energy Analysis is an important BIM Use to the program
- Provide assistance and guidance in choosing Energy Analysis software applications (based on capabilities, feature sets, output, etc.)
- Prioritize requirements, features and capabilities of the BIM – Energy Analysis integration, including deciding which features are not necessary or not worth the technical cost
- Review the actual results of BIM – Energy Analysis integration and provide feedback to optimize the process

2.5.5 BIM Use Leads

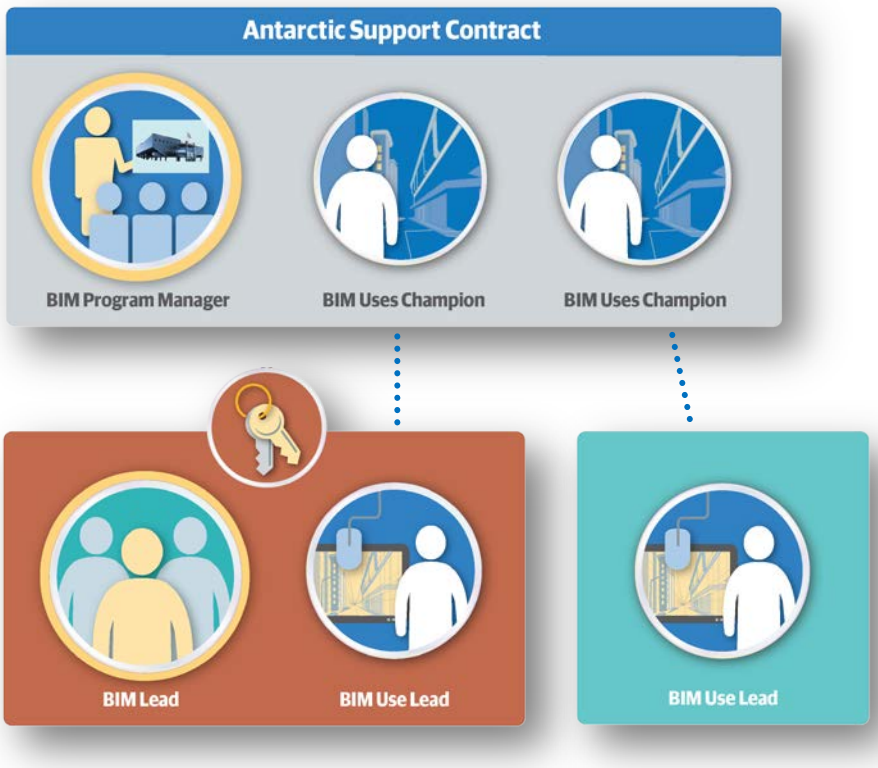
Each BIM Use will have a technical Subject Matter Expert (SME) within the BIM production effort. This person ensures the successful technical execution of that use for the program.

BIM Use Leads are critical in making the BIM Use successful for several reasons, including:

- Many of the BIM Uses are not commonplace for all BIM work, especially within the design and construction industries. Energy Analysis and Phase Planning (4D/Schedule Simulation) are good examples.
- Consistency across the entire program is very important, and some BIM Uses become very technical. It is far better to have person X at firm A be the BIM Use Lead for all firms that employ that use, than to have each firm drive that Use independently, with inconsistent processes and results.

Each BIM Use Lead:

- Provides technical leadership for the successful execution of a given Use
- Develops detailed technical process maps for implementation and execution of the Use
- Provides technical support, in the form of answering questions and providing technical libraries, best practices, and tutorials, for that Use



Note: BIM Use Leads may be personnel in the AE firms, the USAP, or a third-party group.

2.5.6 Current USAP Personnel

Currently, the following roles are held by these people at the USAP:

ROLE	CONTACT
BIM Program Manager	Kevin Gibbons
BIM Use Lead: Drawing Generation	Matt Liffengren
BIM Use Lead: Model Review	Matt Liffengren
BIM Use Lead: Energy Analysis	Kyle Hoppe
BIM Use Lead: Cost Estimating	Dale Jacobs
BIM Use Lead: Schedule Simulation	Rita Pitman (w/Julie Bonneau)

SECTION 3

BIM Planning

Every project within the USAP program is required to plan carefully in advance for BIM development and delivery. Each BIM Owner will develop and deliver a BIM Execution Plan (BIMxP) to the USAP prior to beginning design work, or as otherwise agreed. This section discusses requirements for this plan.

3.1 General

While BIM planning for a given project is left up to each BIM Owner the USAP anticipates these basic steps:

1. Review the USAP BIM Standard thoroughly and in detail, including this document and all accompanying technical baseline content. This includes vetting of issues and questions with the BIM Program Manager.
2. Develop a detailed BIM Execution Plan using the provided USAP template. This is not a form to be filled out; rather, the template provides a framework for the planning process. If it is more efficient, the BIM Owner has the authority to augment the template to include internal requirements (file locations, additional project team information, supplemental BIM requirements or guidance, etc.) in lieu of creating two separate documents.
3. Conduct a BIM kickoff meeting with the USAP BIM Program Manager to discuss BIM in the context of the project, review the project-specific BIMxP, discuss the BIM Standard, and resolve any questions, issues, or conflicts.

3.2 BIM Execution Plan

As part of pre-planning coordination, a BIMxP template will be provided by the BIM Program Manager and must be used as the basis for developing a project- and BIM Owner- specific BIMxP; that is, a plan specific to a given design or construction firm developing a BIM for a given project. This template is loosely based on the Penn State University bSa-sponsored and approved template, and has been edited to address the USAP's program-specific requirements. There is currently one template for both capital project delivery methods employed by the USAP (DB and DBB).

Each BIM Owner will develop a separate BIMxP, which is a project deliverable for their project. The BIMxP will be reviewed in detail during the BIM Kickoff meeting. It is critical that the BIMxP identify the BIM Owner's BIM Lead and other critical team members as required in the Standard. Further guidance on the USAP BIMxP is provided in section 3.4 below.

3.3 BIM Kickoff

Once the BIM Execution Plan is complete and has been submitted, the BIM Lead must conduct a kickoff meeting with the BIM Program Manager to review the project and the BIMxP, as well as discuss the path

forward. Developing the agenda for this meeting is the responsibility of the BIM Owner and can essentially be based around the Table of Contents of the BIMxP.

The BIMxP deliverable will not be considered complete and accepted until after this meeting has occurred and any issues identified in the meeting are resolved to the BIM Program Manager's satisfaction.

3.4 Guidance

The USAP BIM Execution Plan template provides instructions and some guidance for completing the individual sections of the document. This section provides additional guidance.

3.4.1 Overview

In this section, the project team shall discuss in depth how this project, and the BIM specifically, will support the USAP's overall vision for BIM. Specific tangible actions shall be documented in section 1.3 - Vision. It is expected that the team developing the BIM will follow these actions.

The team shall develop a narrative that outlines the process for developing and maintaining the BIM and document this in section 1.4 - Executive Summary. Process Map diagrams may be inserted in this portion of the plan for clarity and as supporting information if the BIMxP author desires. It is expected that the team developing the BIM will read and follow this narrative.

3.4.2 Roles and Responsibilities

This section is not intended to replace other project rosters which list all team members. It is intended to capture a short, consolidated list of key BIM personnel that, at a minimum, aligns project team members by name to the specific Roles defined in section 2.5 of this Standard.

3.4.3 Goals and Uses

In this section the BIMxP author shall list key BIM Goals and BIM Uses. No narrative is necessary unless one or more Goals needs further explanation. It is important to remember that the lists themselves are not nearly as important as the planning and discussions that lead to these lists.

Goals should be project-related, not BIM-related. For example: "Successfully perform clash detection in Navisworks" is not an appropriate goal, but "Ensure design is free of major conflicts" is (noting "3D Coordination" as a Potential BIM Use).

3.4.4 Production

This section shall specify technical details of execution. Details of completion should be self-evident.

3.4.5 Coordination and Collaboration

The team shall develop a simple and effective narrative that discusses coordination and collaboration internally and with the USAP and other BIM Owners. Process Map diagrams may be inserted in this portion of the plan for clarity and as supporting information if the BIMxP author desires.

3.4.6 Use Plans

The team shall develop a short narrative that describes the planned execution of each BIM Use listed in section 3 of the BIMxP, providing process and technical details. Process Map diagrams may be inserted in this portion of the plan for clarity and as supporting information if the BIMxP author desires.

3.4.7 Quality Control

In this portion, the BIMxP author shall identify processes and procedures that the project team will use to deliver models to the USAP that are compliant to this Standard as well as to project-specific requirements. This portion of the BIMxP shall also define QC roles and responsibilities by project team member name. It is important that this section be well developed in part since strategies for QC vary by project, phase, firm, and scope of work, and so a simple standardized approach is not appropriate (see section 7 of the Standard for additional information).

3.4.8 Deliverables

This section shall list all BIM-specific deliverables. No narrative is necessary unless further explanation is needed. This list should be a plan as well as a record, especially for when BIM deliverables are submitted that are not part of the original plan, or when delivery dates change.

3.4.9 Changes / Deviations

As noted in this Standard (including sections 2.3 and 4.5.2), changes or deviations to the USAP BIM Standard are expected when executing specific projects; however, these changes must be coordinated and approved in advance through the proper channels and procedures, and documented in this section of the BIMxP.

In every case, it is important to first state the essential problem, and then the requested change that is expected to solve the problem. Sometimes there are other and better solutions to a given problem, and often several “problems” (that are really veiled solutions) have a common root that is the real problem.

For example, stating “Need text size changed to value X” is a solution, not a problem. The real problem behind this request is probably something like “Text is too large to properly annotate drawings”, and after careful discussion the solution could involve a deeper change to the keynoting system. Or, it could simply be the user is using the wrong text style for annotations.

In all cases, specific examples of the stated problem should be provided along with the request.

Requests that are denied should also be documented along with the reasons for denying the request. This should be done even for benign reasons (for example, events overcome the initial request, or a better method for solving a problem is developed and the initial request is withdrawn). This is important for future reference, in part to ensure similar or same requests are not submitted more than once.

SECTION 4

BIM Production

This section describes standards for production (creation) of the BIM, whether during Design or Construction. It does not address uses of the BIM, which are discussed in section 6.

4.1 General

Industry terminology for BIM Production in the Design Phase is Design Authoring, whereas similar activities during the Construction Phase are referred to as Record Modeling. When considering BIM Production for USAP projects, it is important to *not* separate design from construction since the same standards are applied to and enforced during either project phase, and because in some delivery contracts such as Design-Build, these phases will overlap.

The Penn State University (PSU) BIM Project Execution Planning Guide is one of the authoritative documents regarding BIM planning and execution. It describes Design Authoring as follows:

> *A process in which 3D software is used to develop a Building Information Model based on criteria that are important to the translation of the building's design.*

This definition can be applied to BIM Production in both the design and construction phases.

4.2 Software

Design and Construction teams are required to use the following BIM Authoring software on all new construction and renovation projects:

DISCIPLINE	APPLICATION	VERSION
Architecture	Autodesk Revit	2016
Structural	Autodesk Revit	2016
Mechanical HVAC	Autodesk Revit	2016
Electrical	Autodesk Revit	2016
Mechanical Piping	Autodesk Revit	2016
Site Utilities	Autodesk AutoCAD Civil3D	2016
Telecom	Autodesk Revit	2016
Fire Protection	Autodesk Revit	2016

Any software not listed in the table above or elsewhere in the Standard must be submitted to the USAP for approval prior to use. Discussions regarding potential use of alternative software shall occur during the development of the BIMxP.

4.3 Model Setup

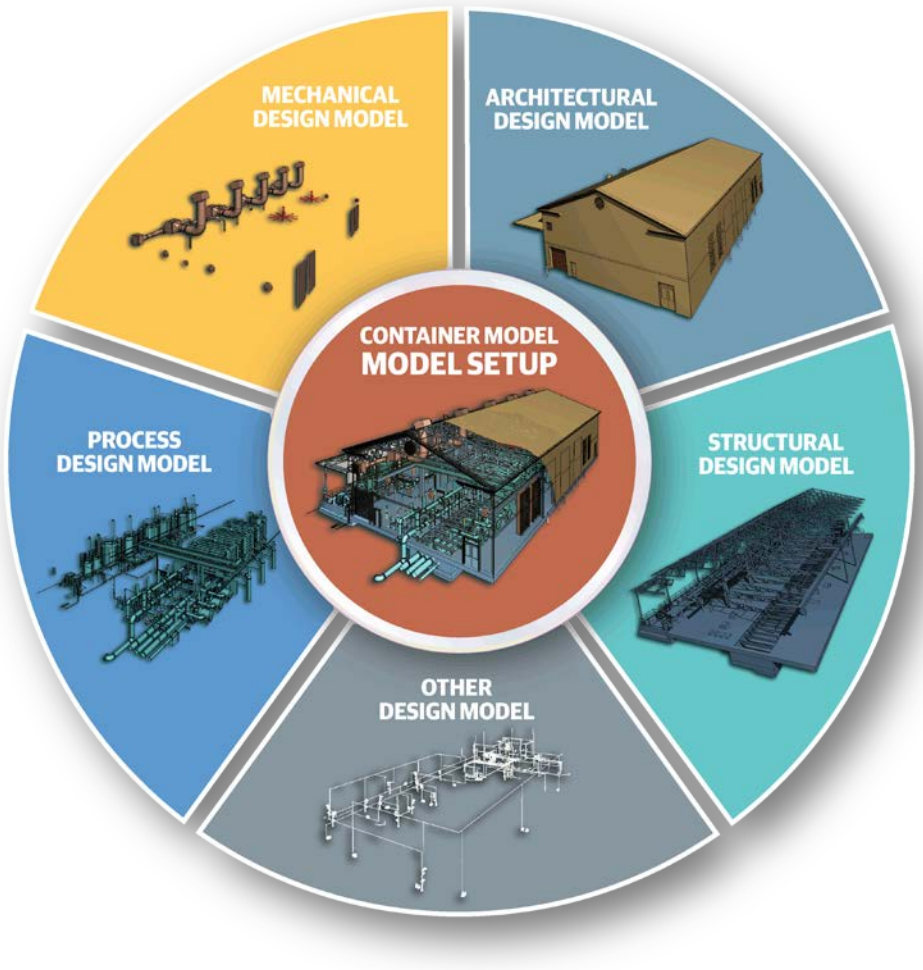
This section outlines the setup of model files. It covers file naming and a standard for organizing the model into multiple files.

The file name for Models will be: USAP-XXXXXX-YY-ZZ.Format

USAP	United States Antarctic Program
[XXXXXX]	USAP BIM Code: Provided by USAP, 6 digits
[YY]	Discipline Code: AR, ST, ME, EL, PL, FP, etc.
[ZZ]	Model Type: DM for Design Model, CM for Container
[Format]	File Format: (*.rvt for Revit, *.dwg for Civil3D)

BIM Owners may use a different naming convention for their own production purposes, as long as the above naming convention is followed for models delivered to the USAP; this is important for USAP internal short and long-term consistency, standardization, and streamlining of processes.

Each design discipline will have its own Design Model (DM). A single Container Model (CM) will be used to bring all discipline models together for general review, data extraction, and other purposes. Both Design Models and the Container Model will be provided whenever native models are required as a deliverable (see section 8.2).



4.4 Units and Coordinate System

All models must be coordinated relative to real world or site coordinates. Revit models will have a datum established at the Project Origin of the models. Details for each project will be provided by the BIM Program Manager. The creation and management of that common reference point is to be identified and documented in the BIMxP.

Revit Project North and Plan North must be identified and documented graphically in the BIMxP. Both the Project Origin and Shared Coordinates (both Revit functions) will be set up and used to align the Site Models and Revit Models to the true site location and rotation.

Dimensional precision for drawings will be set to 1/16" or smaller fractions. Greater precision (smaller fractions) must be used for design modeling to represent the true dimensions and locations of objects. Drawing and model precision must be documented in the BIMxP.

4.5 Content Management

This section provides requirements for BIM support content for 3D modeling and 2D drawing.

4.5.1 Project Startup

At the start of a project, the BIM Program Manager will provide the BIM Owner (AE, GC, or other) a *BIM startup package* that includes the most current versions of the following:

1. USAP BIM Standard (this document)
2. USAP BIM Execution Plan template
3. USAP Standard Revit Templates, one each for Architecture, Structural, Mechanical/Plumbing (which includes Fire Protection), and Electrical (which includes Fire Alarm, Telecommunications, Security, etc.)
4. USAP Standard Civil3D Template
5. USAP standard Revit Shared Parameter files, one each for Architecture, Structural, MEP, and General
6. USAP standard base Revit Family content

Standards defined in the package include:

3D MODEL STANDARDS	
Revit Workset naming conventions	Building sectoring
Phasing	Families
File naming conventions	Component data/properties
2D DRAWING STANDARDS	
Standard line weights and line types	View types
Filled Regions (Hatch Patterns)	Project units
Dimension Styles	Revisions
Object Styles	Graphic scales
Text styles and annotation symbols	Drawing naming conventions
Title block with parameters	

The BIM Owner must use these items provided by the USAP to start the project because they set the baseline standard for drawing and data standards. Management of this content, such as where these files reside on servers, is left up to the BIM Lead.

4.5.2 Changes

It is understood that over time various project needs, updates in technology, updates to the USAP standards, and the natural forward development of content libraries will drive change. While these changes are welcome and encouraged, it is critical that they be managed.

All change requests must be vetted through the BIM Program Manager as described in section 3.4.9.

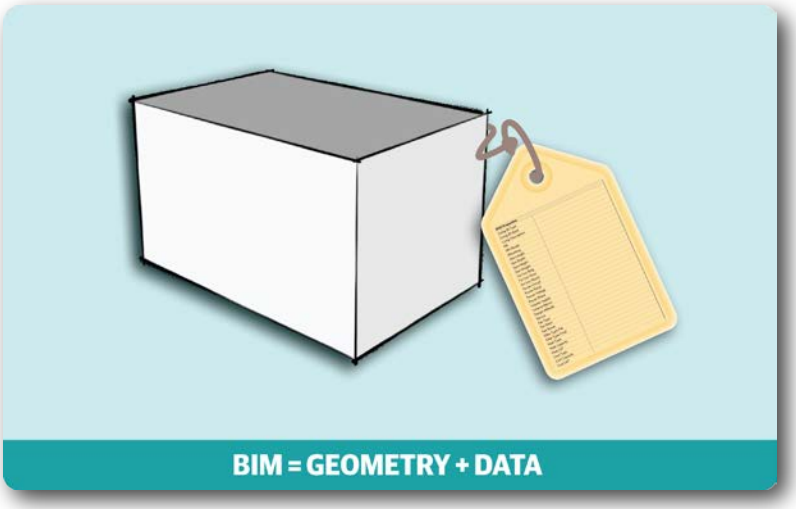
4.6 BIM Development

Each BIM will progress through the project lifecycle, from early concept stages to post-construction and occupancy. This section provides guidance for this BIM development. It is not the intent of this section to define who is responsible for any given level of development of geometry or data; rather, the purpose is to simply define the level of development for geometry and data at any given point. It is the responsibility of the BIM Owner at that stage in the project to meet these requirements.

The BIMForum Level of Development (LOD) Specification 2015 section 2.2 provides an accurate description of the difference between Level of Detail and Level of Development:

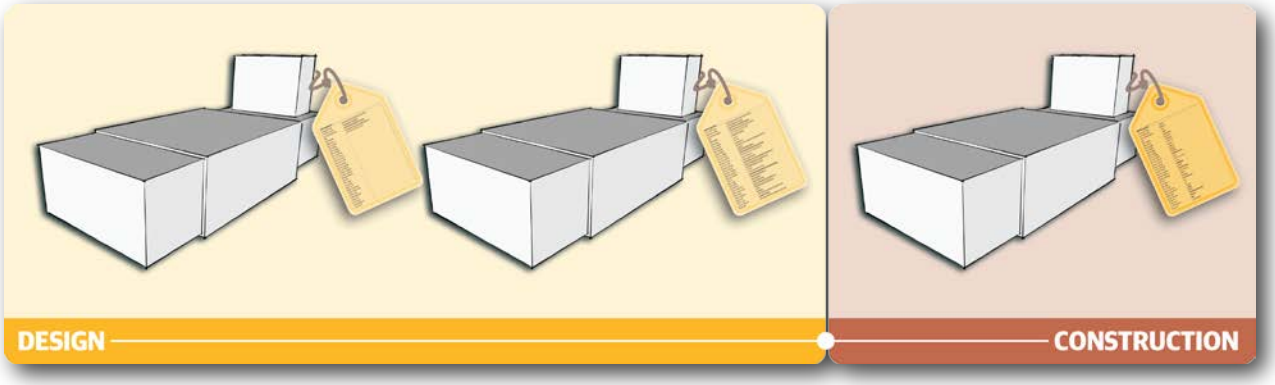
> *Level of Detail is essentially how much detail is included in the model element. Level of Development is the degree to which the element's geometry and attached information has been thought through – the degree to which project team members may rely on the information when using the model.*
>
> *In essence, Level of Detail can be thought of as input to the element, while Level of Development is reliable output.*

At its essence, Building Information Modeling boils down to **Geometry**, a 3D visual representation of the design in the form of components or elements, and **Data**, specific information linked to the geometry that is descriptive of those components or elements. Either without the other loses its value. One



without the other is not BIM.

The USAP recognizes that geometry and data may progress at different rates and somewhat independently of each other throughout the project. The different rates are driven by the availability of information at a given stage – typically driven by decisions made during the project phases – as well as the desired BIM Uses at a given point. Notice that in the diagram below, the geometry is well set early on and doesn't change, while the data that describes the geometry is augmented during design then changed during construction.



For this reason, BIM Development is discussed independently for Geometry and Data.

4.6.1 Geometry

The minimum expected geometrical LOD of the BIM is to be driven by the level of design and/or construction at any phase, as well as the required BIM Use for that stage of the project. The USAP acknowledges and adopts the BIMForum Level of Development Specification 2015, and uses the numbers and detailed verbal and graphic descriptions in that document to specify expected LOD for various stages in the life of a project. In general, these are:

PROJECT STAGE	LEVEL OF DEVELOPMENT
Conceptual Design	100
Design Development, Detailed Design	200 / 300
Construction	300
Operations	300

Appendix A to this Standard, "BIM Level of Development Matrix" provides a detailed breakdown of LOD standards for geometry in the models at various stages of the project lifecycle. BIM geometrical development must follow these specific requirements.

The BIMForum LOD Specification defines LOD 500 as follows: "The Model Element is a field verified representation in terms of size, shape, location, quantity, and orientation." It is expected that all model elements in a USAP will reach this point, having been field verified for size, shape, location, etc., but that most elements will not reach LOD 400, which includes a level of detail unnecessary for the USAP BIM goals. It is expected that geometry will be taken to LOD 300, then field verified (as LOD 500).

USAP also acknowledges there is no strict correspondence between Levels of Development and design phases. Additionally, LOD amongst disciplines can and likely will be different from each other at various stages of the project. For example:

Conceptual Design

- Architectural model is likely at LOD 100.
- Structural model may not have begun.
- MEP model may not have begun.

Design Development

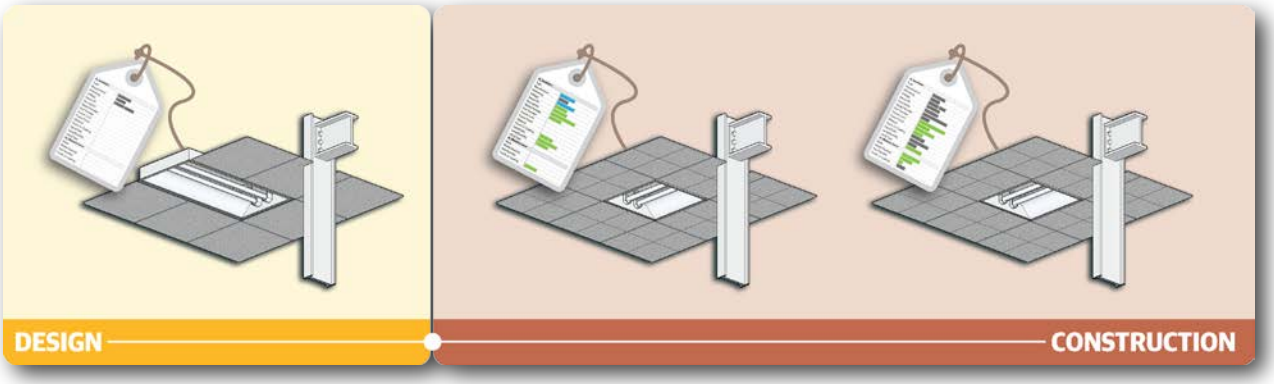
- Architectural model is at LOD 200 or 300. Generic cladding materials are identified, and floor plan is modeled with appropriate wall thicknesses and materials.
- Structural model is at least at LOD 200 with generic framing system and concrete in place.
- MEP model is at LOD 100 or 200 with plumbing, heating ventilation, and cooling systems laid out, and ready to be sized.
- Fire Protection is at LOD 100 at best, with most components such as sprinkler heads and branch lines not shown at all.

Final Design

- All models completed to LOD 300, with sizes and material selections finalized for all primary building elements.
- Some items such as electrical wiring are only represented diagrammatically, perhaps only in 2D.
- Sprinkler head locations are not shown at all.

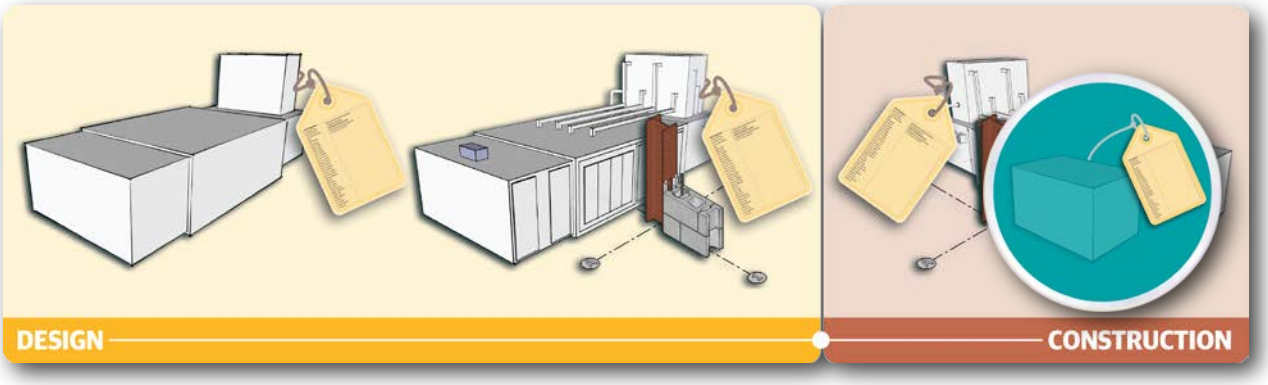
Geometrical changes during construction are not necessarily intended to increase the level of detail of an object. Rather, the progression of LOD during construction is about final positioning and layout of an object. Using two examples:

1. **Light fixtures**: At the end of design, a 2x4 light fixture represents the design basis fixture in terms of size, shape, location, manufacturer, and model number. During construction, a separate design change results in the need to replace this fixture with a 2x2 fixture made by the same company. The geometry and location must change, without an increase in the level of detail. With regard to the data, while the manufacturer remains the same, the model number and several other properties (i.e. nr lamps, total lumens, etc.) must change. At the end of construction, several required properties such as panel and circuit numbers, as well as USAP



Asset ID must now be filled in.

2. **Air Handlers**: At the beginning of design, an AHU (air handling unit) is massed out for general size and location. By the end of design an actual design basis unit has been specified and modeled, with basic data attached. During construction, the specified unit is purchased and installed, but its location changes. The model must be updated to reflect the new location, size, shape, and connection points, but the new geometry need not contain a greater level of detail, and the data remains the same.



4.6.2 Data

This section discusses BIM data development through design and construction, keeping in mind the critical end goal of providing accurate and complete data for Operations. Key data requirements that are discussed herein focus on BIM Development as well as important BIM Uses such as Design Review, 3D Coordination, and Energy Analysis.

BIM is only geometry if it contains unusable data (and therefore, not BIM). It is the responsibility of the USAP to properly define and communicate data capture requirements for the BIM Owner in each phase of a project. Models that contain non-compliant data can produce the following unwanted results:

- Incorrect data creates confusion at a minimum and inaccuracies at the worst.
- Superfluous data can overwhelm downstream attempts at successful use because it creates a need to filter through and find what's important.
- Duplicate and inconsistent data further exacerbates the problem because downstream users have to sort through it and create extensive custom mappings to suit their purposes.

To preempt these problems, a finite Data Definition has been developed with which all USAP BIM projects must comply (see Appendix B)[2].

A few key principles of the USAP BIM Data Definition:

1. One of the key drivers for the property sets is quick access to accurate, important design information in the model (e.g. Navisworks) during all stages and into Operations.

[2] The USAP acknowledges the Construction-Operations Building Information Exchange (COBie, https://www.wbdg.org/resources/cobie.php) format, but postpones its specific inclusion to a later date as needs evolve. It is not convincing at this point that COBie solves the problems and vision the USAP is facing. The key here is to look at real needs first, and solve real problems first, because COBie is not an end to itself.

2. Future integration with Maximo is another key driver, however this is a smaller sub-set of data of the overall Data Definition and requires additional research to confirm validity.
3. Every object of any significance (door, light fixture, pump, piece of equipment, AHU, etc.) will have a BIM Object ID assigned at the earliest stage possible and maintained throughout the life of the BIM. This property can pull its value from a design documentation label such as “AHU-1” or “PMP-06”. The value may be unique to that object (such as AHU-2) or to the object type (such as light fixture F-1).
4. A single property set has been developed that applies to many seemingly different objects such as telephones, power outlets, LAN boxes, fire alarm devices, etc.
5. Some object types like AHUs, light fixtures and sprinkler heads require a property set unique to that type.
6. All values must be filled in, as possible, for all phases of the project. For example, in design the Manufacturer and Model Number will be filled in from basis of design (specifications) information. In construction, these values will be reviewed changed if necessary based on actual installed units.
7. The BIM Owner at any given stage of the life of the BIM is responsible for accurate and complete entering of all data.

4.7 Phasing

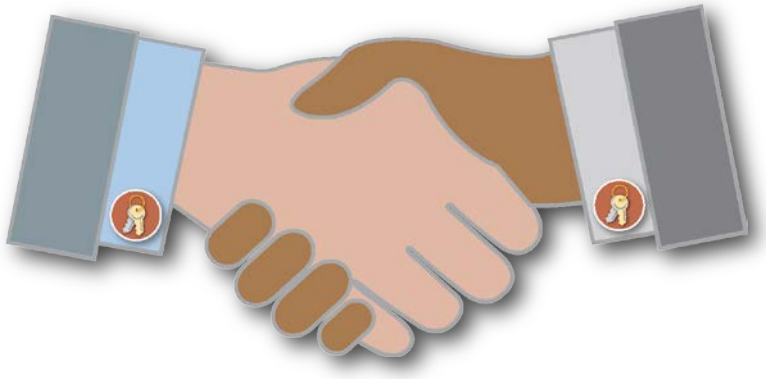
Some projects may require the use of the Phasing features of Revit. It is expected that the number and types of phases will vary by project, yet naming of Phases in Revit must be consistent across the entire USAP program.

Therefore, no Phasing technical standards are established in this document; any project that uses the Phasing features of Revit must coordinate with the BIM Program Manager carefully to agree on Phases and Phase Names. These must be documented in the BIMxP.

SECTION 5

Coordination and Collaboration

This section discusses BIM coordination and collaboration.



5.1 General

The USAP sees BIM as a highly effective and efficient collaboration and coordination tool for design and construction, and expects each BIM Owner to leverage this tool to perform these tasks. How this tool is leveraged on each given project should be documented in section 5 of that project's BIMxP. This section of the BIMxP must be maintained throughout the project to reflect such things as changes in processes, coordination meetings and milestones, and technical modifications.

5.2 Interfaces

It is expected that BIM Owners will use the BIM to coordinate within their own organizations and address interfaces between design disciplines and construction components. How this occurs is not dictated by this Standard, but must be documented in the BIMxP for the project.

Most of the design and construction work in Antarctica is performed in the context of physically separated structures that make up an interdependent station (similar to a campus or city that is managed holistically by one entity – the USAP. This is in contrast to design projects elsewhere in the world where two adjacent buildings are owned and managed by separate, independent entities with little or no communication between them (such as a bank and an office building on the same block). It is therefore critical and required that each BIM Owner collaborates and coordinates carefully and systematically with other BIM Owners whose projects interface or even overlap. Coordination is done in concert with the knowledge of the USAP Project Manager(s).

The USAP will provide details of related concurrent work as well as the station-wide efforts and systems that require collaboration and coordination. The means, methods, and timing of such cross-BIM interfacing is not stipulated here, but must be planned and documented in the BIMxP for the project.

5.3 Strategies

The following general strategies are some examples of ways to leverage the BIM for coordination:

1. Link Design Models together in a Container Model and perform a Model Review (see section 6.3.2). The review can be focused on just specific discipline models or the entire facility. It can

include other projects' Design Models (provided by USAP or other BIM Owners directly). A checklist of design items to review and coordinate is highly useful and serves as a record of coordination.

2. Provide Design Models to other BIM Owners to check for specific interface points (e.g. site utility hookups to facility systems). Do this often, as appropriate to the project.
3. Produce quantity take-off schedules/reports and cross-check against previous such reports and other BIM Owners' similar reports, searching for missing items, inconsistencies and opportunities (see section 6.3.11).
4. Perform 3D Coordination with a focus on Clash Detection (see section 6.3.4).
5. Ensure as many 2D drawings and schedules as possible are generated directly from the BIM; those that are not should be linked into (called out from) the BIM (see section 6.3.3). When the BIM – geometry and data – is the source of design documentation, there is a consistency between documents not achievable otherwise, which applies to both coordinated and uncoordinated issues alike, greatly assisting in finding and resolving these issues.

5.4 Technological Solutions

The USAP's vision is of a cloud-based collaboration environment that enables all BIM-related coordination tasks to occur seamlessly and virtually. At this time, this vision is not feasible for various technical reasons that will be resolved over time. In the interim, the following direction is provided regarding these specific aspects of collaboration:

- File Transfers will occur via secure means approved by the USAP.
- Model Reviews and similar meetings will be coordinated and hosted by the AE or GC unless otherwise directed by the USAP. This includes coordination of technology required to support any virtual meetings.
- Dissemination of materials to be reviewed and collection of comments prior to a review meeting are the responsibility of the AE or GC. The BIMxP for each project will define how this is accomplished.
- Video conferencing and/or remote presentation technology will be used during model reviews and similar sessions for presentation of Navisworks models as well as to share other information. This is required at each model review meeting unless otherwise stipulated by the USAP for a specific project. The BIMxP for each project will define the extent to which the Navisworks model is utilized and how it is reviewed during each meeting.

SECTION 6

BIM Uses

6.1 General

A significant effort goes into producing or developing a Building Information Model; the return on this investment is realized by leveraging the BIM for various purposes. The industry generally recognizes these as *BIM Uses*.

BIM Uses cannot be realized until the BIM has been developed, and at the same time the development of the BIM must take into account the desired BIM Uses; in fact, the Level of Development at a given stage of the project may be determined by a given use (see section 4.6). The purpose of this section is to identify the expected BIM Uses up front so that the key requirements for these uses can be addressed in the production of the BIM. Following general industry standards, the uses are generally organized by project phase.

Several BIM Uses have been determined to be of high value to the USAP. These are documented in as much detail as is appropriate. In every case, the stated Purposes of the BIM Use are of highest importance as they provide guidance for the successful implementation of that Use.

Other BIM Uses have been determined to be of little or no value to the USAP at this time. These have been listed to document that they were considered.

The BIM Uses described in this standard are project-independent; that is, not all BIM Uses listed in this section apply to all projects. Each project should determine the Uses that will provide the most value to the project, and document those in the BIMxP for that project.

The following table is a summary of Software Requirements for BIM Uses. It is expected that this table will grow over time, through subsequent versions of the Standard, as the USAP standardizes on different BIM Use software applications.

STANDARD SECTION	USE	SOFTWARE	VERSION
6.3.2, 6.4.1	Model Review	Autodesk Navisworks Manage	2016
6.3.3	Drawing Generation	Autodesk Revit, Autodesk Civil3D	2016
6.3.4, 6.4.4	3D Coordination	Autodesk Navisworks Manage	2016
6.3.11	Cost Estimation	Autodesk Revit, Autodesk Civil3D	2016

6.2 Pre-Planning Phase

6.2.1 Project Phase Planning

Description

The process in which a 4D model (3D models with the added dimension of time) is utilized to effectively plan the phased occupancy in a renovation, retrofit, or addition; or to show the general construction phasing sequence and space requirements on a building site. 4D modeling is a powerful visualization and communication tool that can give a project team, including the owner, a better understanding of project milestones and construction plans.

Purpose

Primary purposes for USAP are expected to be sporadic and periodic, and include:

1. Potential use for CRARY lab which will need renovation at some point in time.
2. Potential use for upgrading of IT network.
3. Potential use for South Pole station raising.

It is important to note that this BIM Use will be more valuable to the USAP once existing models are developed.

Owner

USAP will take ownership of this use when required, possibly outsourcing the work; results would be provided to design and construction firms.

Technical Requirements

Technical requirements are similar to those for construction schedule simulation; see section 6.4.2. However, a simplified solution can be employed using the TimeLiner feature of Navisworks.

Process Overview

The process is similar to that for construction schedule simulation; see section 6.4.2. However, a simplified process can be employed using the TimeLiner feature of Navisworks.

Other Notes

None at this time.

Deliverables

None at this time.

6.2.2 Site Analysis

Description

The process in which BIM/GIS tools are used to evaluate properties in a given area to determine the most optimal site location for a future project. The site data collected is used to first select the site and then position the building based on other criteria.

Purpose

As of the development of this version of this document, this BIM Use is not expected to be of significant value to the USAP.

6.2.3 Programming

Description

The process in which a spatial program is implemented in a BIM to efficiently and accurately assess design performance in regard to spatial requirements, enabling the project team to analyze space and understand the complexity of space standards and regulations. Critical decisions are made in this phase of design and bring the most value to the project when needs and options are discussed with the client and the best approach is analyzed.

Purpose

Primary purposes for USAP are expected to be sporadic and periodic, and include:

1. Developing initial program requirements and prioritizing these requirements.
2. Capturing spatial requirements and tracking progress through design.

Owner

USAP will take ownership of this use when required, possibly outsourcing the work; results would be provided to design and construction firms.

Technical Requirements

1. Software: To be determined at time of implementation.
2. Geometry: To be determined at time of implementation.
3. Data: To be determined at time of implementation.
4. Technical: To be determined at time of implementation.

Process Overview

The process begins with the development of a project space program within specialized software or within a standard spreadsheet, to include data such as space type, quantities, areas, categories etc. This program is then integrated (import or via 2-way link) into the BIM software, where geometry is automatically created to represent the various spaces. The BIM software is then used to adjust location and arrangement of spaces into various “bubble diagram” options.

Other Notes

None at this time.

Deliverables

None at this time.

6.3 Design Phase

6.3.1 Existing Conditions Modeling

Description

The process of developing a BIM of the existing conditions for a site, facilities on a site, or specific facility. Existing conditions can be modeled with BIM authoring software or can be generated through 3D laser scanning point cloud technology, depending on the need and purpose.

Purpose

Primary purposes for USAP are expected to be sporadic and periodic, and include:

1. Provide context and support of design and construction of new additions to existing facilities.
2. Periodic raising of the South Pole station (snow drift), to identify and mitigate risks such as safety, and plan for utility extensions.
3. Project-specific needs as determined and documented separately.

Owner

USAP will take ownership of this use, possibly outsourcing the work; resulting existing conditions model(s) will be provided to design and construction firms as and when needed.

Technical Requirements

1. Software: Requirements will depend on modeling method: when generating a BIM, follow requirements for BIM Production; when generating a point cloud, scanning service provider to coordinate with BIM Program Manager to determine software and output requirements; 3D Reality Capture and Modeling solution selection (such as Bentley ContextCapture, Autodesk ReCap) should be discussed and mutually agreed upon to facilitate consistency and project integration.
2. Geometry: Capture geometry as appropriate to specific purpose, which should be defined in the BIMxP for that project.
3. Data: Capture data as appropriate to specific purpose, which should be defined in the BIMxP for that project.
4. Technical: No additional special technical requirements.

Process Overview

Process will be determined by each specific existing conditions project, and by the method and desired output (e.g. BIM production v laser scanning).

Other Notes

It is important to carefully examine and define the needs and purposes of each existing conditions modeling project, as well as the state of the technology at that time, prior to determining process, level of development, and delivery method.

Deliverables

Deliverables will be dependent upon both the chosen modelling method(s), and the USAPs specific geometry and data requirements.

6.3.2 Model Review

Description

The process in which stakeholders navigate through a BIM in 3D to review the design, then provide feedback on multiple design aspects. During design, this is generally done as part of formal or informal standard design review processes, when 2D drawings and specifications are reviewed. During construction, this is generally done during review of major submittals and RFIs, and as part regularly scheduled construction meetings.

Purpose

Primary purposes for USAP include:

1. AE and Contractor-driven model review meetings to identify issues and enumerate comments.
2. Internal USAP reviews of the design.

Owner

Each BIM Owner is required to take ownership of this Use for their BIM.

Technical Requirements

1. Software: Autodesk Navisworks Manage 2016.
2. Geometry: All geometry from all disciplines to be included. All model construction or superfluous geometry to be purged from the model.
3. Data: All data must be included prior to publishing (from Revit or Civil3D or other). No additional special data requirements.
4. Ensure Autodesk Navisworks Manage NWC export utility is installed for Autodesk Revit 2016, to enable NWC file export from Revit.
5. Revit 'Navisworks Settings' for NWC export must be documented in section 6 of the BIMxP. Settings include (but are not limited to) the following:

INTERFACE > DISPLAY UNITS	
Linear Units	Feet and Inches Fractions
Angular Units	Degrees
Decimal Places	8
Fractional Display Precision	1/256
FILE READERS > REVIT	
Convert Element Parameters	Elements
No conversion of linked CAD formats or files	
Shared Coordinates	
Export of Entire Project	

6. Navisworks appended NWD files must include:

- Pre-defined views to be mutually agreed upon and stated in BIMxP
- Search sets for each Revit Model category

- Per-discipline search sets

7. The NWC file names must match the native models from which they are generated (these native models must follow USAP BIM Standards, see section 4.3).
8. The NWD file name will be USAP-XXXXXX-YYYY-ZZZZ-AA.nwd:

USAP	United States Antarctic Program
[XXXXXX]	USAP BIM Code: Provided by USAP, 6 digits
[YYYY]	Year, such as “2016”
[ZZZZ]	Month and Day, for example “0321” for March 21
[AA]	Model Type: MR for Model Review, 3X for 3D Coordination, 3R for both
nwd	File Format: (*.nwd)

Process Overview

1. Export Navisworks NWC cache files from Revit ‘Navisworks Export’ 3D view, one per BIM.
2. Create Navisworks appended NWF file from aggregated NWC cache files.
3. Verify that views and search sets have been included.
4. Publish Navisworks NWD for delivery.
5. Schedule Model Review Session with relevant parties. Navigate in Navisworks Manage through published and appended Navisworks NWD model.

Other Notes

1. Navisworks Manage 2016 has been chosen as the software of choice for formal Design Review sessions for several reasons, including:
    a. Supported currently by the USAP.
    b. Ease of portability. Navisworks is part of the Autodesk suite alongside Revit. This facilitates exporting, and maximizes compatibility. File sizes are fractional relative to authoring software files.
    c. Ease of navigation.
    d. Ability to import multiple industry CAD formats (in addition to Revit).
    e. Economically attractive because files can be viewed in free viewer (Navisworks Freedom).
2. Interim, informal and ad-hoc design and construction reviews are also expected as the need arises. The USAP will make use of 3D PDF output from the various models for these reviews. It is not expected that these will include entire buildings, but will be focused on specific areas and systems of interest. All BIM Owners must be capable of producing 3D PDFs[3].

Deliverables

For every formal scheduled Design Review session, provide the following:

1. Navisworks cache (*.nwc) files, one per BIM.

[3] There are several Revit plug-ins that provide this capability; see the BIM Program Manager for details.

2. Navisworks appended (*.nwd) file of Navisworks cache (*.nwc) file(s).
3. Native BIM files will not be required as part of Design Review submissions.

6.3.3 Drawing Generation

Description

The process in which the BIM is used to generate drawings and drawing sets. This includes design, construction and record and/or as-built drawings.

Both the BIMs and 2D Deliverables are considered contract documents. To promote efficiency, continuity, and consistency the USAP expects 2D Construction Documents to be extracted directly from the BIMs.

Purpose

Primary purposes for USAP include:

1. Ensure model is center point of design, and reflects design intent.
2. Ensure model is center point of construction, and accurately and completely reflects constructed conditions.

Owner

Each BIM Owner is required to take ownership of this Use for their BIM.

Technical Requirements

Same as for BIM Production; see section 4.

Process Overview

Drawings are generated and composed per software-defined workflows.

Other Notes

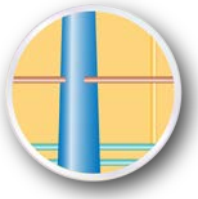
1. The USAP acknowledges the current impracticality of or lack of pressing need to model every construction component within the BIM. Some details will be developed as strictly 2D drawings. However, all 2D details must be created within the Revit model and properly linked to the drawing set, and to the 3D model were appropriate. Drawings shall not be developed in 2D CAD applications such as AutoCAD and then imported into Revit sheets; they shall be developed completely within Revit.
2. The USAP recognizes that often BIM-generated drawings have a different look and feel from traditional drawings, while conveying the same information necessary for construction. Extreme efforts should not be employed to generate traditional-looking construction drawings. Alternative and non-traditional drawings, drawing styles, and graphic conventions that simplify the production of BIM-generated drawings will be accepted as long as the construction information is accurate and complete.

Deliverables

1. The BIM must truly reflect the drawings and specifications. These documents are required, where possible, to be generated as a product of the model to minimize the potential for disconnect between drawings and the model.
2. All building drawings will be delivered as part of the Revit models, as well as in PDF format, according to the project contract.
3. All site/civil drawings will be delivered in Civil3D (*.dwg) format, as well as in PDF format, according to the project contract.

6.3.4 3D Coordination

Description



The process in which software is used to determine physical and operational conflicts in the design. This is accomplished through the use of two major virtual building systems review processes: Model Review and Clash Detection. These work tightly together throughout the project to assure efficient, high-quality design and construction. Model Review is performed with a special focus on physical, clearance, and operational clashes, and serves to ensure design intent compliance and to catch issues that clash detection software doesn't. Clash Detection is the process in which software is used to virtually determine physical conflicts between building systems in the design, then assign ownership and track clash resolution.

Purpose

Primary purposes for USAP include:

1. Eliminate the major system conflicts prior to installation.
2. Plan for operations and maintenance activities.

Owner

Each BIM Owner is required to take ownership of this Use for their BIM.

Technical Requirements

1. Software: Autodesk Navisworks Manage 2016.
2. Geometry: All geometry from all disciplines to be included. All model construction or superfluous geometry to be purged from the model.
3. Data: All data must be included prior to Revit export. No additional special data requirements
4. NWC files must be appended (not merged).
5. Clash Test Strategy/Strategies are expected to be purpose driven (i.e. overall clashes during design phase, versus specific systems clashes during construction phase prior to their installation), and must be documented in the BIMxP.
6. Clash Test Rules must be documented in the BIMxP.
7. Clash Test Results are required to have Grouping and Assignment procedures.
8. Ensure clash viewpoints are saved at a good angle and with any supporting annotation. It is expected that care will be taken to avoid unnecessary viewpoints, i.e. sensible clash grouping.
9. The NWD file name will be USAP-XXXXXX-YYYY-ZZZZ-AA.nwd:

USAP	United States Antarctic Program
[XXXXXX]	USAP BIM Code: Provided by USAP, 6 digits
[YYYY]	Year, such as "2016"
[ZZZZ]	Month and Day, for example "0321" for March 21
[AA]	Model Type: MR for Model Review, 3X for 3D Coordination, 3R for both
nwd	File Format: (*.nwd)

10. The HTML report file name will be USAP-XXXXXX-YYYY-ZZZZ-AVB.html

USAP	United States Antarctic Program
[XXXXXX]	USAP BIM Code: Provided by USAP, 6 digits
[YYYY]	Year, such as “2016”
[ZZZZ]	Month and Day, for example “0321” for March 21
[AA-BB…]	Clash test being reported, where AA and BB denote the disciplines involved, using National Cad Standard two-character discipline codes (see also section 4.3); for example: AR-ST = Architectural against Structural ST-ST = Structural against itself ST-PL = Structural against Plumbing Multiple disciplines can be designated with additional dashes, for example: AR-ST-ME = Architectural against Structural and Mechanical HVAC.
Html	File Format: (*.html)

Process Overview

1. Perform clash detection activities internally as part of the design process. Timing of these activities must be documented in the BIMxP.
2. Schedule Model Review session for adjudicated clashes prior to major deliverable (recommended 2 days). Design Team representative, USAP representative, walkthrough adjudicated clashes in clash test alongside Navisworks model.
3. Perform full, documented sign off approval with comments from design discipline leads.
4. Issue clash-adjudicated Navisworks NWD model to USAP.
5. If necessary, follow-up with a model review session (in the event of disagreements).
6. If necessary, issue addendum of new clash-adjudicated, appended Navisworks NWD model.

Other Notes

1. Process and output of 3D Coordination will be considered a QC item. Provide clash-free design, and provide proof, where clash test report showing adjudicated clashes is acceptable proof.
2. Any executed Clash Tests must be present in the clash-adjudicated, appended Navisworks NWD model deliverable.

Deliverables

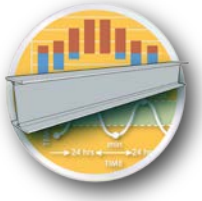
Clash Detection plan, documented in BIMxP, with requirements listed above (e.g. strategies, rules, etc.).

At each formal interim submittal, provide clash-adjudicated, appended Navisworks NWD model.

Provide clash test reports in the native *.html format produced by Navisworks showing:

1. Clash Test Strategy employed.
2. Clash Test Rules selected for exclusions.
3. Clash Test Results Grouping, Status, Assignments with comments.
4. Annotated Clash Viewpoints.

6.3.5 Structural Analysis



Description

The process in which specialized structural analysis software utilizes the BIM to analyze and determine the behavior of a given structural system to assist in optimization and refinement of the structural design.

Purpose

As of the development of this version of this document, this BIM Use is not expected to be of significant value to the USAP. However it may be of use to the BIM Owners.

6.3.6 Mechanical Analysis

Description

The process in which the BIM is used to analyze the mechanical HVAC systems to assist in optimization and refinement of the mechanical design.

Purpose

As of the development of this version of this document, this BIM Use is not expected to be of significant value to the USAP. However it may be of use to the BIM Owners.

6.3.7 Lighting Analysis

Description

The process in which analytical modeling software use the BIM to determine the behavior of a given lighting system, including artificial (indoor and outdoor) and natural (daylighting and solar shading) lighting. Based on this analysis further development and refinement of the lighting design can occur to create effective, efficient, and constructible lighting systems. The application of this analysis tool allows for performance simulations that can significantly improve the design, and performance of the facility's lighting over its lifecycle.

Purpose

Primary purposes for USAP include:

1. Optimize lighting solutions during design.
2. Assist with maintenance, especially during certain seasons.

As of the development of this version of this document, this BIM Use is not expected to be leveraged by the USAP. However it may be of use to the BIM Owners.

6.3.8 Energy Analysis

Description

The process in which one or more building energy simulation programs use a properly adjusted BIM to conduct energy assessments for the current building design.

Purpose

Primary purposes for USAP include:

1. Inspect building energy standard compatibility.
2. Seek opportunities to optimize proposed design to reduce structure's life-cycle costs.

Owner

Each BIM Owner is required to take ownership of this Use for their BIM.

Technical Requirements

1. Software: TBD.
2. Geometry: TBD.
3. Data: TBD.
4. Technical: TBD.

Process Overview

TBD.

Other Notes

None at this time.

Deliverables

Native analysis software file.

Reports of Analysis in a usable format will be required at defined set points. USAP will request native files on an as need basis.

6.3.9 Sustainability Evaluation

Description

The process in which a BIM project is evaluated based on standard sustainability design criteria to optimize and refine sustainability design strategies and assist in calculations.

Purpose

As of the development of this version of this document and given the current state of this technology, this BIM Use is not expected to be of significant value to the USAP. However it may be of use to the BIM Owners, and other BIM Uses may be helpful in this area.

6.3.10 Code Validation

Description

The process in which the BIM is utilized to check the model parameters against specific code requirements. This could involve specialized code validation software.

Purpose

As of the development of this version of this document and given the current state of this technology, this BIM Use is not expected to be of significant value to the USAP. However it may be of use to the BIM Owners, and other BIM Uses may be helpful in this area.

6.3.11 Cost Estimation

Description

The process in which the BIM is used to assist in the generation of accurate quantity take-offs and cost estimates.

Purpose

Primary purposes for USAP include:

1. Track costs during design and construction.
2. Screen and optimize choices of materials.

Owner

Each BIM Owner is required to take ownership of this Use for their BIM.

Technical Requirements

1. Software: Autodesk Revit 2016
2. Geometry: All geometry must be modelled to the minimum required LOD per section 4.6 for the specific project milestone at which the deliverable is being requested.
3. Data: All data must be present in the BIM to the minimum requirements per section 4.6 for the specific project milestone at which the deliverable is being requested.

Process Overview

1. Use Excel to create a new, empty workbook. Workbook file naming to follow each discipline Model file naming guidelines outlined in 4.2 Model Setup (with Excel *.xlsx file extension).
2. Export ODBC (Open Database Connection) from Revit[4].

Other Notes

1. Each BIM Owner will be required to generate a comprehensive bill of materials (BOM) for their BIM, at various stages of the project, as a direct output from the native BIM.

[4] For details and/or support on this feature of Revit, contact the BIM Program Manager.

2. The USAP will also use the native models to generate a BOM at various points during the project to validate AE and/or GC quantities, and to run scenarios in a cost and materials optimization exercise.
3. It is important to note that the BIM is not expected to generate costs or cost estimates, only material take-offs.

Deliverables

Excel spreadsheets generated.

Raw Revit ODBC database (*.dsn) source files used, per BIM.

6.3.12 Acoustic Analysis

Description

The process in which the BIM (primarily the geometry) is used to assist in the analysis of acoustics and sound properties within the spaces of the facility.

Purpose

As of the development of this version of this document, this BIM Use is not expected to be of significant value to the USAP. However it may be of use to the BIM Owners, and other BIM Uses may be helpful in this area.

6.4 Construction Phase

6.4.1 Model Review

This BIM Use is of high value and importance during Construction. Details are covered in section 6.3.2.

It is expected that regular (possibly weekly) Model Review sessions will be held during construction, led by the BIM Owner at that time, for that project, to facilitate owner and team understanding of construction progress and issues.

6.4.2 Schedule Simulation

Description

The process in which a 4D model (3D models with the added dimension of time) is utilized to effectively plan the construction sequence of events. The BIM is linked to the official construction baseline schedule so that accurate simulations can be generated and reviewed for issues, problems, and opportunities. As the schedule is modified to reflect actual conditions, simulations can be generated to assist in tracking actual progress, showing problems, delays, accelerations, and future opportunities.

Purpose

Primary purposes for USAP include:

1. Provide better understanding of baseline, actual/current, and projected construction schedule.
2. Review, correct and optimize schedule through detailed visual analysis.
3. Assist in ongoing schedule tracking through visual analysis.

Technical Requirements

1. Software: *TBD*
2. Geometry: *TBD*
3. Data: *TBD*
4. Technical: *TBD*

Process Overview

TBD

Other Notes

None at this time.

Deliverables

TBD

6.4.3 Site Utilization Planning

Description

The process in which BIM is used to graphically represent both permanent and temporary facilities on site during multiple phases of the construction process. It may also be linked with the construction activity schedule to convey space and sequencing requirements. Additional information incorporated into the model can include labor resources, materials with associated deliveries, and equipment location. Because the 3D model components can be directly linked to the schedule, site management functions such as visualized planning, short-term re-planning, and resource analysis can be analyzed over different spatial and temporal data.

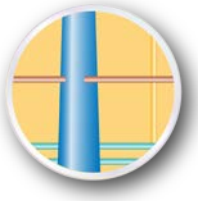
Purpose

Primary purposes for USAP include:

1. Provide better understanding of construction staging and site utilization, and its effect on ongoing operations.
2. Review, correct and optimize site utilization during construction through detailed visual analysis.

As of the development of this version of this document, this BIM Use is not expected to be leveraged by the USAP. However it may be of use to the BIM Owners.

6.4.4 3D Coordination



This BIM Use is of high value and importance during Construction. Details are covered in section 6.3.4.

It is expected that all proposed changes, whether initiated as submittal substitutions, RFIs, or other, will be incorporated into the BIM prior to execution (even prior to request) in an effort to proactively review the proposed change for all potential issues. Part of this review should include 3D Coordination, through visual navigation and review and/or clash detection.

All proposed construction changes will be required to prove that such 3D Coordination has been performed in the BIM prior to acceptance.

6.4.5 Construction System Design

Description

The process in which 3D System Design Software is used to design and analyze the construction of a complex building system (e.g. form work, glazing, tie-backs, etc.) in order to optimize planning and uncover problems that typically are difficult to find in traditional 2D approaches. This use can also be thought of as virtual mock-ups.

Purpose

While the USAP sees potential value in this, actual purposes and requirements will be determined by the needs of each specific project.

6.4.6 Digital Fabrication

Description

The process of using digitized information to facilitate the fabrication of construction materials or assemblies, including sheet metal, structural steel, pipe cutting, and prototyping.

Purpose

The purpose is to help streamline and optimize the downstream phase of manufacturing so that it has minimum ambiguities and enough information to fabricate with minimal waste.

While the USAP will not require integration of this BIM Use, it is recommended that construction entities explore the value for their specific projects, given that the BIM will be highly developed and available.

6.4.7 3D Control and Planning (Digital Layout)

Description

The process of using the BIM to layout facility assemblies or automate control of equipment's movement and location. The information model is used to create detailed control points to aid in assembly layout.

Purpose

While the USAP will not require integration of this BIM Use, it is recommended that construction entities explore the value for their specific projects, given that the BIM will be highly developed and available.

6.4.8 Field Management and Tracking

Description

A process in which Field Management software, including Field BIM software, is used during the construction, commissioning, and handover process to manage, track, task, and report on quality (QA/QC), safety, documents to the field, commissioning (Cx), and handover programs, connected to Building Information Models (BIM). Field Management makes the model available across a construction site in 3D.

The goal of Field Management and Field BIM is to ensure conformance to contract documents, compliance to safety regulations, and performance to owner's project requirements, through BIM-based workflows out in the field and at the point-of-construction.

Purpose

Primary purposes for USAP include:

1. Digital linking of construction and operational documents to the corresponding objects in the BIM.
2. Ensuring availability of the 3D model for construction use, across the entire site.

As of the development of this version of this document, this BIM Use is not expected to be leveraged by the USAP. However it may be of use to the BIM Owners.

SECTION 7

Quality Control

This section discusses quality control for all BIM activities executed for the USAP.

7.1 General

Strategies for quality control of the BIM will vary depending on Subcontractor, project, phase of project and general scope. Each BIM Owner must develop a strategy appropriate to their work and document it thoroughly in section 7 of the BIMxP.

To ensure model quality in every project phase and before information exchanges, project-specific procedures must be defined and implemented. Quality control of deliverables must be accomplished at each major BIM activity including design and/or model reviews, coordination meetings and project delivery milestones. The standard of data quality shall be established in the planning process, agreed upon by the team and documented in the BIMxP.

Native BIM files will be subject to QC review by the USAP.

7.2 Expectations

It is unrealistic to expect error-free work 100% of the time. Although this is theoretically possible, it is impractical given budgetary constraints and the nuances of human productivity. It is, however, feasible to create a work environment wherein typical and routine errors are either eliminated or discovered during in-house quality checks so that design and construction deliverables are significantly error free when submitted to the USAP. It is also reasonable to expect that project teams learn from mistakes, become more efficient over time, share information, take pride in their work, leverage technology, strive for excellence, and consistently work to exceed client's expectations. In doing so a Subcontractor is more likely to deliver high-quality BIM products to the USAP.

All BIM Owners are expected to adhere to the standards and requirements set forth in this Standard. Where deviations are needed, they must be vetted through the process described in section 3.4.9.

7.3 USAP Strategies

One of the USAP's goals for implementing BIM is to minimize rework and reduce inefficiencies. Producing quality models during both design and construction is a necessary step in achieving that objective. The USAP may perform quality checks and/or engage an independent party to do so on its behalf. The following methods as well as others may be employed to enforce quality on any given project:

- Confirmation from the Subcontractor of compliance to their Quality Plan
- Check for compliance to the project-specific BIMxP
- Visual checks of the model and any details not generated directly from the model
- Data extraction and manual or automated validation
- Validation of proper federation of native models
- 3D coordination and other model analysis
- Confirmation that model supports project-specific BIM Uses

7.4 Suggested Subcontractor Strategies

Each BIM being developed during the lifecycle of a project must be pre-planned with considerations for model content, level of detail, format, parties responsible for updates, and distribution of the model and data to various parties. Each discipline contributing to the BIM should have a responsible person to coordinate the model (e.g. the BIM Lead). This person should participate in all major BIM activities and will be responsible for addressing issues that might arise with keeping the model and data updated, accurate, and comprehensive.

Some key strategies that should be employed are (this list is not intended to be all-inclusive):

1. Ensure the BIMxP is being followed.
2. Generate quality checklists, and use these with QC personnel sign-offs.
3. Ensure all models are included in reviews and deliverables, for all disciplines.
4. Ensure all models follow appropriate LOD for current phase/discipline/element types.
5. Ensure model structure as outlined in BIMxP is followed.
6. Ensure model accurately reflects design intent and/or as-built conditions, and that details not generated directly from the model are accurately represented in the model.
7. Ensure document production compliance with the standards in this document (see sections 4 and 6.3.3) and the BIMxP.
8. Ensure 3D Coordination is performed regularly (Model Review and Clash Detection, see sections 6.3.2 and 6.3.4).
9. Coordinate with other BIM Owners' models (including the site model) to ensure that geographic alignment is accomplished (see sections 4.4 and 5.2).

SECTION 8

Deliverables

Through design, construction, and close-out phases, the USAP expects that every BIM Owner will have several main deliverables, as outlined in this section. The timing and schedule for these deliverables will vary based on project and scope of work, but must be documented in the BIMxP. The purpose of this section is to describe these deliverables and list requirements for each.

8.1 Execution Plans

Every BIM Owner is required to deliver a BIM Execution Plan (BIMxP); see section 3. Note that section 8 of the BIMxP includes a list of deliverables that must be completed.

8.2 Native Models

Every BIM Owner will deliver Native Design and Container Models (DM and CM, see section 4.3), fully editable, following all standards and technical requirements as set forth in this document and the individual BIMxPs. Purpose of this delivery is:

- During development (design and/or construction), for review to ensure standards and BIMxP compliance
- At completion of design, to ensure completeness of model and editability by next BIM Owner (e.g. the construction contractor)
- At completion of construction, to ensure completeness of model and editability by future BIM Owners (e.g. the ASC) for future renovations, additions, etc.

As an example: Entities are required to submit the native Revit models, cleaned up, following standards, templates, etc.

Revit deliverable files must not contain links to any external files. All geometry in native models must include relevant and accurate data.

8.3 Published Models

Every BIM Owner is required to deliver aggregated models in a published, immutable format for further down-stream use. This is what will be used for USAP Design Reviews. It is also expected that this will be the foundation for the smart city grid and operations support.

As an example: Entities are required to submit Navisworks cache models (*.nwc).

8.4 BIM Use Deliverables

For each BIM Use identified as a requirement for a given project in the BIMxP section 3, the BIM Owner will provide deliverables as noted in that section of this document (see section 6).

For example:

- For Drawing Generation, entities are required to submit native *.rvt, *.dwg, and *.pdf files of the drawings, per section 6.3.3.
- For 3D Coordination, entities are required to submit clash detection reports from Navisworks, per section 6.3.4.

BIM in Operations

This is a visionary portion of the document that discusses how the USAP wants to use BIM to optimize operations and maintenance support.

9.1 General

Although this section is primarily targeted at internal USAP staff it also stipulates requirements to all BIM Owners (including AEs and GCs). Additionally, it emphasizes the fact that only through the diligent development of the BIM and adherence to the Standard can the USAP achieve its goals for BIM in Operations. This portion of the Standard provides AEs and GCs additional context for geometric standards, data capture requirements, and other stipulations contained in previous sections of this document.

The term Operations implies both Operations and Maintenance.

9.1.1 Vision

Use of the BIM models to operate and maintain buildings and other structures is the ultimate desired end-state for the USAP. All BIM work executed during the Design and Construction phases of a project is undertaken to support this programmatic goal. The standards discussed in previous sections for BIM in Design and Construction only provide value insofar as the activities eventually support BIM in Operations.

The vision for BIM in Operations is to have a fully integrated system allowing parties to navigate the 3D model and view all data associated with the modeled elements. This system is tied into Maximo and any other relevant systems, allowing real time access to required data to operate and maintain all parts of the facility.

USAP BIM VISION

Building Information Modeling (BIM) is an intelligent model-based business process that provides the United States Antarctic Program (USAP) with the opportunity to make quantum improvements in the way it plans, designs, constructs, and manages buildings and infrastructure. Using BIM, the USAP will optimize the entire lifecycle of facilities management to deliver safe, efficient, and world-class science facilities in Antarctica.

The USAP will capitalize on BIM's ability to fully capture and transfer data from Design through Construction to Operations and Maintenance in order to use interoperable building information models and supporting technology to inform all facility management business decisions. Use of a common model that is transferred between BIM Owners through the entire design-construction process is envisioned, when practical, to minimize rework.

9.1.2 Strategy

There is no clear roadmap at this point in time to reach the desired end-state. There are technical solutions that offer promises needing confirmation through market research and pilot projects. In lieu of full integration between the model(s) and Maximo, the USAP plans to use manual means and methods to extract data, examine for accuracy, and import into Maximo to leverage the data

capture completed during both Design and Construction.

Periodic programmatic assessments will be conducted in conjunction with pilot projects to quantify current and future returns on investments as well as to validate the predicted value of the USAP BIM Vision can be realized. Off Ramps will be available at these assessment points if it is necessary to revise the BIM implementation plan and/or Vision for the USAP.

9.1.3 Operational Use Cases

The final goal is a fully automated system that supports 3D model navigation and handles bi-directional integration between the BIM and Maximo. The 3D model, used through an integrated system, will allow the following activities:

- Navigate the facility virtually to locate equipment, fixtures, etc. that need service.
- Search the system using information in Maximo or the model to perform required operations tasks.
- Update geometry and data in the BIM and Maximo to reflect changes during operations.

9.1.4 Principles of Success

Successful use of BIM during Operations requires compliance to the following during Design and Construction:

- BIM Owner engagement with USAP Operations personnel throughout Design and Construction
- USAP identification of required Operations data prior to and during Design and Construction
- Consistent and accurately entered data during all phases
- Consistent and accurately modeled geometry during all phases
- Maintenance of Design Intent BIM during Construction so that the BIM delivered to Operators is current and accurate
- Data export and transfer to Maximo and any other appropriate system
- Maintenance of the Design Model and Maximo information during Operations, as well as the overall BIM integration system (as chosen per section 9.3.2)

9.2 BIM Owner Requirements

The primary reason for implementing BIM in the USAP is use of the model during operations. The USAP expects to gain value from the model and data prior to resolving any technical issues related to integration with other systems (e.g. Maximo). Every BIM Owner is a key stakeholder in the process of developing a viable model with usable data to achieve use of the model as stated. Therefore, at any phase of the project, the current BIM Owner is required to create and maintain an accurate and robust set of BIM files to either be handed to the next BIM Owner (e.g. Design to Construction) or for final use in Operations. This work is separate from selecting and implementing a fully automated solution that integrates BIM with Maximo (which is discussed in section 9.3.1).

In order to achieve success, every BIM Owner must embrace and act on the Principles of Success (section 9.1.4 above) and ensure the following items are carefully followed:

- Enter all required data as defined in the USAP data templates and documentation. Pay close attention to those properties that are specific for operations (see section 4.6.2).
- Enter data consistently per the USAP Data Definition Schedule (Appendix B).
- Always use the change control system established in section 3.4.9 for data property additions or modification. Never add or modify data properties without careful coordination with and approval from the BIM Program Manager.
- Model all required objects to the appropriate level of detail as per the Standard (see section 4.6.1).
- Ensure geometrical accuracy of the model.
- Perform regular Model Reviews with cross-discipline coordination to verify data and geometry accuracy.
- Quickly and accurately respond to data property changes and additions as they occur.

Accurate execution of these tasks will ensure the resulting BIM is robust, consistent and flexible enough to integrate with a future solution. This is critical to achieving the BIM in Operations Vision.

9.3 Innovation Efforts

Successfully integrating with Maximo and realizing a BIM for operations solution will require innovation in the form of research and testing efforts during pilot projects that will likely parallel some of the Design and Construction phases. Resolving these technical issues was not included in development of this BIM Standard. This section outlines possible steps to these activities.

It is expected that in time, these innovation efforts will result in solidified solutions that become standards in this document.

9.3.1 Test BIM-Maximo Integration

Maximo integration relies on successful data exchange between the products used to create the BIM and Maximo itself. Initial market research indicates that other organizations have achieved the goal of integration; however, more research is needed to confirm success. All integration solutions, whether automated or manual, rely on accurate data residing in the model and correct data mapping. Exercising this data exchange during a pilot project will identify gaps in the system which can be easily addressed during the design phase. This effort would be independent of any BIM creation efforts by the BIM Owners but will provide essential feedback.

The USAP must ensure the following tasks are completed in regular intervals during Design while developing an integration solution:

1. Produce manual data exports from BIM applications and import into a Maximo test sandbox. One common exchange format is COBie but current versions of Maximo have several formats and methods to use.
2. Document gaps in any integration method used and address as possible, or discard.
3. Document gaps in BIM data, then update standards and templates as needed to address the gaps and coordinate modeling updates with BIM Owners.
4. Document gaps in the Maximo sandbox and coordinate updates.

5. Develop and maintain a separate document that discusses details of BIM integration with Maximo.

Regular integration of these steps will find and address problems that would limit the final system used for BIM in Operations.

9.3.2 Choose BIM for Operations Solution

There are several solutions on the market today advertising the ability to achieve the BIM in Operations vision. Solutions such as *EcoDomus*, *ModelStream* and *YouBIM* all offer systems to integrate 3D Models with CMMS systems such as Maximo. The operations phase is far enough in the future that choosing a solution now is risky and unrealistic. The previous sections have discussed the approach to ensure our BIM deliverables and Maximo system can easily use the best solution available when actual integration for Operations makes business sense.

The USAP must ensure the following tasks are completed approximately two years before BIM in Operations functionality is desired. The suggested timing is based upon typical organization funding and planning cycles, as well as technological implementation schedules. Funding and planning complexities within the USAP may require initiating these steps even earlier.

1. Identify available BIM to Maximo integration and Operation systems, from manual to fully automated solutions.
2. Update and maintain this document's discussion of BIM integration with Maximo (section 9.3.1), to include results of market research and related review activities.
3. Investigate solutions with best fit for the BIM for Operations vision.
4. Identify organizations who have implemented the same solution and conduct market research with them directly.
5. Test the solution to identify potential gaps and document how they can be overcome, keeping in mind that most robust solutions require some customization, and that customization of the system is one way to address gaps.
6. Make final system decision and scope out implementation and any software, hardware and customization needs.

It will be critical to be mindful of the Operations handoff deadline in order to have the system fully functional.

9.4 Other BIM Uses

In addition to discussions above, there are many other potential areas of value for the BIM during Operations and Maintenance. Some of these include:

- Building Preventative Maintenance Scheduling
- Mechanical Analysis
- Energy Analysis
- Evacuation Planning
- Fire Spread Simulation
- Building Systems Analysis
- Space Management and Tracking

- Disaster Planning

Current implementation of these BIM Uses typically requires extreme customization of software, which contradicts one of the USAP Guiding Principles for implementation of BIM (e.g. use of COTS software). The USAP will continue to monitor software solutions and conduct market research to determine feasibility of implementing these types of solutions in the future. These future Uses are listed here for reference and tracking.

Keys to Success

In order for the overall BIM vision to be realized, it is critical that the following be carefully analyzed and incorporated into the master BIM plan for the USAP.

1. The Design Intent Model must be maintained accurately during construction, incorporating all submittals, RFIs, mods, etc. to finally become an accurate Record Model. This means the geometry and data are updated to match existing conditions. Because this can be an exhaustive (and perhaps costly) effort, a clear plan with clear guidelines must be established early.
2. A BIM Owner during construction will be vital to #1 above. This may be the GC, but it is expected that this could/should be someone else, either in the USAP or a 3rd party.
3. To be able to leverage the BIM for anything during Operations, all data must be standardized and accurate, and this standardization must begin at the very earliest stages possible. This likely means a fair amount of up-front logistical and technical legwork, as well as some careful planning and scheduling. This investment, however, is critical and will produce the desired results.
4. BIM Owners must adhere to all standards in this document and their respective BIMxPs.
5. The USAP must continuously evaluate current and emerging technologies and incorporate them as appropriate into the standard.