

NATSPEC National BIM Guide



NATSPEC National BIM Guide

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Contact us via email at bim@natspec.com.au.

You can also discuss issues in the BIM Forum at bim.natspec.org.

NATSPEC BIM Position Statement

NATSPEC believes that digital information, including 3D Modelling and Building Information Modelling will provide improved methods of design, construction and communication for the Australian construction industry. Further, NATSPEC supports open global systems. This will result in improved efficiency and quality.

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Formatting conventions used in the NATSPEC National BIM Guide

In addition to the text formatting conventions used for Section headings, Clause titles, Table headings, etc, the Table below shows other text formats used in this document and what they indicate:

Text type	Example	Indicates
Normal italicised text	<i>Project BIM Brief</i>	The name of a specific document or standard.
Bold italicised text	<i>CAD/Drawing Standards</i>	The generic title for a Reference Document. Acceptable Reference Documents are listed in the <i>NATSPEC BIM Reference Schedule</i> . The specific document that applies in place of the generic title for the purposes of a particular project is recorded in the <i>Project BIM Brief</i> .
Grey bold text	Data Reuse	A cross reference to a Section, Clause, Table, Diagram, etc that can be found in this document. Note: Numbers for these items are not included in the reference.
Dark red text	gbXML	A term or abbreviation that is defined in the Glossary . Note: Colouring is only applied to the first instance of the term to appear on each page.
Blue text	www.natspec.com.au	Hyperlink/weblink

Notes

In this document:

- 'the Guide' shall be taken to mean the *NATSPEC National BIM Guide*.
- The numbering of Tables, Diagrams and Figures is derived from the Clause in which they appear.

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1 INTRODUCTION

1.1 Purpose of the NATSPEC National BIM Guide

The *National BIM Guide* is a reference document to be read in conjunction with the *Project BIM Brief* which outlines the particular requirements for each project. It is expected that the *Project BIM Brief*, whether developed using the *NATSPEC Project BIM Brief* or other means, is formulated by the client in consultation with the project team. The Guide can also be used as a planning tool by consultants to clarify the services they propose to provide when preparing bids for projects.

The *National BIM Guide* is to assist clients, consultants and stakeholders to clarify their BIM requirements in a nationally consistent manner. This will reduce confusion and duplication of effort.

The *National BIM Guide* is an adaptation of the *VA BIM Guide* and the development philosophy is to retain as much of the original document as possible. It is expected that common sense will interpret Americanisms appropriately.

1.2 Project requirements

A clear brief and an understanding of the constraints associated with a project have always been essential prerequisites for a successful project. The same principles apply to formulating requirements for the use of BIM:

- Taking the time to understand what is needed.
- A realistic assessment of capabilities and capacities.
- Defining the scope of service.
- Managing expectations and risk.
- Apportioning reward commensurate with effort and responsibility.

It is for this reason that legal disclaimers are included in this document – it is the responsibility of its users to apply their professional judgment to determine what is appropriate in a particular situation.

It is strongly recommended that a structured process to define the requirements for using BIM on the project, involving the client and project team, is instigated as early as possible. References to documents that can assist this (such as the Computer Integrated Construction Research Program “BIM Project Execution Planning Guide” Penn State University) can be found at the end of *NATSPEC BIM Reference Schedule*.

1.3 NATSPEC National BIM Guide documents

The *National BIM Guide* works with a number of supporting documents that should be compiled in a coordinated way and read in conjunction with each other. All are freely downloadable from www.natspec.com.au. Click on the ‘NATSPEC BIM’ logo. They are:

- *NATSPEC National BIM Guide* (this document) is a reference document that defines roles and responsibilities, collaboration procedures, approved software, modelling requirements, digital deliverables and documentation standards. It documents a range of possible uses for BIM on projects.
- A Project BIM Brief documents the specific requirements of a project. It can be developed using the *NATSPEC Project BIM Brief* template. In addition to identifying the project and members of the project team, it provides places to specify what BIM is to be used for on the project. It is also used to record what standards from the *NATSPEC BIM Reference Schedule* will apply. This arrangement allows the necessary flexibility for selecting references to suit the particulars of the project.
- *NATSPEC BIM Reference Schedule* is a list of documents and standards provided for consideration as references that can be cited in the *National BIM Guide*. The specific documents chosen to be applicable to a project are recorded in the *Project BIM Brief*.
- *NATSPEC BIM Object/Element Matrix* is a series of Microsoft Excel (.xls) worksheets that defines a large number of objects and elements and their properties by *Unifomat/OmniClass* classification and *Level of Development (LOD)* at different stages in the building’s lifecycle.

The intent of this structure is to allow each edition of the *National BIM Guide* to function as a core reference document and to confine all editing to the *Project BIM Brief*. This allows the *National BIM Guide* to be tailored to individual projects while allowing it to be progressively upgraded in response to users’ needs from edition to edition within a consistent, recognisable framework.

1.4 How to use the NATSPEC National BIM Guide

The *National BIM Guide* is not intended as a one-size-fits-all document defining the use of BIM on all projects. This is not possible. The separate *Project BIM Brief* is used to specify project-specific requirements.

After the requirements for using BIM on the project have been defined and before the project formally commences, the clauses of the *National BIM Guide* which have to be retained, amended or deleted in order to satisfy the requirements are documented in the *Project BIM Brief*.

The *Project BIM Brief* records variations to the *National BIM Guide* and must be read in conjunction with it and the Project Contract.

A key element of the *National BIM Guide* is its requirement for a BIM Management Plan (BMP) (sometimes also referred to as a BIM Execution Plan). The BMP is used to describe in a much more detailed way how the project will be executed, monitored and controlled with regard to BIM in order to satisfy the requirements recorded in the *Project BIM Brief*.

The *NATSPEC BIM Object/Element Matrix* can be used as an aid in the development of the BMP.

Other uses for the *BIM Object/Element Matrix* include:

- As a tool by the project team to decide what information should be included in the model at different stages of the project, and by whom. It can be used for planning and guidance only or to document agreed contractual commitments and responsibilities.
- As it incorporates **Construction Operations Building Information Exchange (COBie)** specific parameters, it can be used during the design, construction and commissioning stages of the project to record information to be handed over for **facility management** purposes.
- It can be used as a reference to assure that all model object parameters follow a consistent naming convention and reflect industry standards.

If and how the *BIM Object/Element Matrix* is to be used on the project should be recorded in the *Project BIM Brief*.

1.5 Waivers

Situations could arise where adherence to parts of this standard may be problematic. In these instances, any waivers negotiated shall be recorded in the Contract.

2 IMPLEMENTATION

2.1 Procurement Strategy

The project procurement strategy will define the BIM model creation, and hence it is imperative that the decision to use **Design-Bid-Build (DBB)** (traditional method), **Design and Construct (D&C)**, **Integrated Project Delivery (IPD)** or one of a number of other procurement methods be determined at the initial stage of the project so that BIM can be properly structured and managed to support the procurement strategy. The contracts will define the integration or separation of risk and responsibilities for the design and construction contracting entities, and therefore, the **Level of Development (LOD)** and division of responsibilities. There may, for example, be only one BIM Manager throughout the project if IPD or D&C is used, and potentially two, a Design and a Construction BIM Manager if DBB is used. Similarly, contractually defined risk will also determine whether there are separate design intent and construction BIM models, or whether they can be combined into one model.

Where the BIM model(s) is to be used for design/documentation and construction, the **BIM Management Plan (BMP)** should address how the model(s) can be migrated between stages effectively with the minimum effort.

Clients often require the **interoperability** of data as a strategic management issue to ensure their access to building information over the life of the capital asset. Therefore, any software that meets the client's interoperability standards is acceptable for use on their projects, subject to their approval. It is also critical that available national standards, classification systems and protocols such as **OmniClass**, **Unifomat** and **NATSPEC** are used in developing the models so that information can be machine read and normalised for the client's management purposes. Unique **Global Unique Identifiers (GUIDs)** assigned in the BIM tools shall be maintained to support data in workflows.

2.2 BIM Responsibilities

BIM authoring tools, data integration, and collaborative team workflow environments shall be used to develop and produce project information and documentation as required by the client's **Submission Instructions**. BIM use should be maximised for project reviews, decision support, design analysis, and quality assurance during all phases of the project. Presentation models, 'fly-throughs', etc may be required to represent the design solution effectively, or in some detail to the client or other stakeholders.

It is the responsibility of all consultants and contractors to have or obtain, at their cost, the trained personnel, hardware, and software needed to successfully use BIM for the project. Equipment used by the subcontractors during the on-site coordination meetings must meet the requirements of the software being implemented so as not to cause delays in modelling and redrawing. All technical disciplines (Design) shall be responsible for the integration and reliability of their data and contribution to the preparation of coordinated BIMs.

2.3 Data Reuse

The ability to own, reuse, and properly manage building data throughout the facility lifecycle accrues significant advantages for the client. Consequently, the accurate creation, management and stewardship of building information during project creation are of utmost importance. Data created during planning and refined during the project execution process can provide a valuable resource for **Facility Management (FM)**. **Final BIM Deliverables** requires that as-built BIM Model(s) be submitted at the end of construction for this purpose.

2.4 Terms of Use

The terms Design Team, Construction Team, and Design/Construction Team have been used in this Guide to assist in defining which group the guidance applies to. However, because the procurement strategies can define risk differently, for some projects the responsibility may shift to either the consulting team or the contracting entity, or both. The Contract should properly define the duties of the parties before BIM modelling begins.

2.5 Open Standards

To ensure the life-cycle use of building information, information supporting common industry **deliverables** shall be provided in existing open standards, where available. For those contract deliverables whose open standard formats have not yet been finalised, the deliverable shall be provided in a mutually agreed format which allows the re-use of building information outside the context of the proprietary BIM software. The formats used are best specified in the BIM Management Plan and shall include, at a minimum, the following standards:

- a. Current version **Industry Foundation Class (IFC) Model View Definition (MVD)** formats:
 - **Coordination:** This format will be required for all deliverables needed to demonstrate the coordination of design disciplines prior to construction or the coordination of construction trades supporting the efficient fabrication, staging, and installation of fabricated building elements. In addition to the Coordination View file(s), where required, the designer and contractor shall provide a report highlighting automatically detected (hard and soft) collisions and identifying those collisions that require further work by the design or construction team.
 - **Facility Management:** Portions of this life-cycle oriented data format may be required for a variety of different building information deliverables that will replace paper deliverables. The deliverables for the FM Handover MVD in a COBie format include, but are not limited to:
 - Verification of the design solution against the **Program for Design (PFD)**.
 - Scheduled building and equipment lists.
 - Construction submittal register requirements.
 - Identification of installed equipment and all tagged building products.
 - Facility handover deliverables.
- b. **Portable Document Format:** Copies of all approved submittals and other documents normally provided in traditional paper-based formats will be provided in PDF format. Documents authored directly by the project team shall be transformed to PDF to allow selection of text within the document. Documents authored by others, but used by the project team (such as manufacturer product data sheets) will be provided as PDFs made available by the manufacturer. If not available as PDFs from their authors, the documents will be scanned to create image-based PDF documents.
- c. **ASTM E57 3D file format (for 3D laser point cloud data):** Copies of approved submittals for depiction of as-built services and building conditions will be provided in ASTM E57 3D file format (conforming to *ASTM E2807*) unless otherwise agreed with the Design BIM Manager.

3 BIM MANAGEMENT PLAN (BMP)

3.1 Introduction

Description

The **BIM Management Plan (BMP)** is a formal document that defines how the project will be executed, monitored and controlled with regard to BIM. It is required that a BMP be developed to provide a master information/data management plan and assignment of roles and responsibilities for model creation and data integration at project initiation.

Requirements

The BMP shall align the project procurement strategy needs and requirements with the PFD, client technical standards, team member skills, construction industry capability, and technology maturity. Through this process, the team members and the project management shall jointly agree on how, when, why, to what level, and for which project outcomes BIM will be used.

In those projects where construction information is available during the design phase (using the **D&C** or **IPD** project procurement strategies), the BMP shall address both design and construction activities. Where a **DBB** (traditional) procurement strategy is used, a separate BMP for design and potentially for construction shall be developed and submitted to the client with specific attention to model and data handover from the design team to the construction team.

The BMP should be considered a living document and shall be continually developed and refined throughout the project development lifecycle as required to ensure the project remains on schedule and meets briefed requirements. Include the proposed method for facilitating this (e.g. scheduled review meetings) in the initial BMP.

3.2 Design BMP

The Design Team BIM Manager shall submit the BMP to the client for review and approval before the start of **schematic design**. Other than uses of BIM excluded by the *Project BIM Brief*, the Design BMP, at a minimum, shall address the following:

Project scope

- a. The project procurement strategy (**DBB**, **D&C**, **IPD**) and how the Design BIM will support the project delivery activity.
- b. Overall plan for achieving client BIM requirements.
- c. BIM qualifications, experience, and contact information for the following: BIM Manager; Lead BIM Coordinators for all major disciplines (Architect, Civil, **MEP**, Structural, etc).
- d. Project schedule aligned to BIM development and progress submittals in compliance with the client's **Submission Instructions**. Schedule to include:
 - Software compatibility testing schedule.
 - Proposed meetings and their purpose (design coordination/clash detection, BMP review, etc).
 - **Progress BIMs** per Design Document Submission. Specify the period in which the Progress BIM recipient is to advise the author/s whether it satisfies their specified requirements, or not.
- e. Documentation of any proposed deviation from the *National BIM Guide* standards for client approval.

Exchange considerations

- f. Strategy for establishing and managing shared file server, if used. If not using a shared file server, provide the strategy for model exchange and handover.
- g. Strategy for hosting, transfer, and access of data between technical disciplines (use of model server, extranet, permitted uses, access rights, security, etc.) A technical evaluation of the options to match the Information Technology (IT) technical needs to the size and complexity of the project, and to provide access by the Design/Construction Team and various project stakeholders, peer reviewers, etc.
- h. Proposed BIM software to be used by each technical discipline team member.
- i. File formats used for project submittal and file exchange.
- j. File exchange protocol.
- k. Legal status the Design Model will have for construction (**Binding**, **Informational**, **Reference**, **Reuse**).

Modelling considerations

- l. The proposed development of Model Elements throughout the project, including the Level of Development (LOD) of each and the author responsible for developing it at each phase of the project.
- m. Strategy for import of **Program for Design (PFD)** information.
- n. Methods for showing functionality of occupants' requirements (proximity of spaces, walking distances, sightlines, etc) and circulation paths for the delivery, supply, processing and storage of materials, etc. e.g. graphics, animated models.
- o. Methods for showing major building equipment space clearance reservations for operations, repair, maintenance and replacement, e.g. graphics, animated models.
- p. Energy modelling strategies.
- q. Strategy for updating and coordinating changes during construction into the final BIM model deliverable files.
- r. Strategy for integration of **Facility Management** information (e.g. COBie).

3.3 Construction BMP

After bid award, the Contractor shall, if required by the client, submit a Construction BMP, outlining the strategy and schedule for utilising BIM technology to execute construction related activities and project coordination. Other

than uses of BIM excluded by the *Project BIM Brief*, the Construction BMP, at a minimum, shall address the following:

Project scope

- a. The project procurement strategy (DBB, D&C, IPD) and how the Construction BIM will support the project delivery activity. When a DBB procurement strategy is used, the Construction BMP shall address the specific strategy for the Design BIM reuse.
- b. Strategy for compliance with project BIM requirements.
- c. BIM qualifications, experience, and contact information for the Construction BIM Manager and Lead Fabrication Modellers for all trades.
- d. List of subcontractors using digital fabrication.
- e. Proposed subcontractor meetings and their purposes (design coordination/clash detection, BIM Management Plan review, etc) integrated into project schedule.
- f. Documentation of any proposed deviation from the *National BIM Guide* for client approval

Exchange considerations

- g. Strategy for software compatibility, file formats, hosting, transfer, and access of data between trades (use of model server, extranet, access security, etc.) A technical evaluation of the options to match the IT technical needs to the size and complexity of the project, and to provide access by the Design/Construction Team and various stakeholders, fabricators, etc.
- h. Proposed BIM Software to be used by the Contractor and Fabrication Modellers.

Modelling considerations

- i. Strategy to assure all trade information is modelled and coordinated.
- j. Methods for showing major building equipment space clearance reservations for operations, repair, maintenance and replacement, e.g. graphics, animated models.
- k. Constructability analysis with BIM.
- l. Proposed trade coordination strategy (clash detection).
- m. Proposed use of digital fabrication.
- n. Utilisation of 4D scheduling and construction sequencing technology.
- o. Integration of as-built conditions and commissioning data into an As-built/Record BIM.
- p. Strategy for updating and coordinating changes during construction into the final BIM deliverable.
- q. Strategy for integration of Facility Management information (e.g. COBie).

3.4 Software Compatibility and Data Flow Testing

Software used for Design and Construction BIM work shall be tested for compatibility by the Construction BIM Manager. The use of software that is not Industry Foundation Class (IFC) compliant in the preparation of models is only permitted with the approval of the client. Versioning of software shall be managed by the BIM teams throughout the project lifecycle.

4 BIM ROLES AND RESPONSIBILITIES

4.1 Team Roles and Relationships

Table 4.1 shows the responsibilities assigned to each role during the development of the BIM Management Plan (BMP) and throughout the project. These are subject to contractual agreements and any variations agreed. The BIM Team should define the working relationships between roles (e.g. request, reporting and approval protocols) so that lines of authority are clear, and to facilitate the efficient resolution of issues as they arise. See also **Collaboration Procedures**.

Table 4.1 – BIM Roles and responsibilities

Defined Role	Responsibility in BIM Management Plan (BMP) Development	BIM Responsibility
Project Manager	Manages and coordinates project execution and BIM to meet procurement strategy and cost containment.	Oversight.
Design Team Project Manager	Team manager and coordinator, BMP.	Coordination & Review.
(Design Team or Construction) BIM Manager	Coordinate BIM use on project, determine schedule of use, sharing activities, quality control, modelling responsibilities and documentation in BMP.	Oversight, Management Execution and Model Exchange.
Lead BIM Coordinator	Assist BIM Manager.	Implementing BIM Manager instructions with (Design or Construction) Team. Representing BIM Manager.
Architecture Team	Design Execution – formulate with BIM Manager. Map BIM use for architectural design.	Modelling and Review.
Structural Team	Engineering – formulate with BIM Manager. Map BIM use for structural design – determine BIM use for structural simulations, analysis and documentation. Identify tools.	Modelling and Review, Model Exchange.
MEP Team	Engineering – formulate with BIM Manager. Map BIM use for MEP design – determine BIM use for simulations, analysis and documentation. Identify tools.	Data Development. Modelling and Model Exchange.
Interior Design Team	Interior Design Execution – formulate with BIM Manager and architect. Map BIM use for interior design.	Data Development, Modelling and Model Exchange.
Sustainability and Energy Team	Engineering – formulate with BIM Manager. Map BIM use for Sustainability, 3 rd Party Rating Systems – determine BIM use for simulations, analysis and documentation. Identify tools.	Data Development Review and use of model.
Building Users Group	Determine facility functionally issues to be modelled and tested.	Development of critical building use issues and inputs for testing, and their review.
Commissioning Agent	Support. Provide architectural, engineering, equipment compliance reports produced in the specified exchange format.	Data Development Review and use of model.
BIM Modelling Application Expert	Support BIM Manager on application specific content, issues.	Modelling and Data Integration.
Quantity Surveyor/Cost Planner	Support alignment of project procurement to BIM development and cost containment strategies.	Data development and integration. Use of model.
Contractor	Receive or help create BIM for constructability and handover for field use. Determine Interference checking responsibility.	Use of model, Review, Model Exchange.
Subcontractor and/or Fabricator (as appropriate)	Off-Site Fabrication – formulate with BIM Manager and designer. Map BIM use for fabrication and shop drawing design. Determine BIM use for simulations of maintenance space analysis and documentation. Identify tools.	Use of model, Modelling and Integration.

4.2 Design Team BIM Manager

As part of the execution of the **Design BIM Management Plan**, the Design Team shall assign an individual to the role of Design Team BIM Manager. The individual shall have sufficient BIM experience for the size and complexity of the project and shall have relevant proficiency in the proposed BIM authoring and coordination software. The individual shall serve as the main point of contact with the client and the Design Team for BIM related issues. Responsibilities shall include the following:

- a. Ensuring development and compliance with the approved Design BMP.
- b. Developing, coordinating, publishing the Design BMP and verifying that all necessary configurations required for the seamless integration of design and construction model information have been implemented.
- c. Coordinating team file management.
- d. Coordinating the set up of shared file server with Design Team IT staff. This shall include interfacing with Design Team IT staff to set up web portal, permissions, etc.
- e. Assembling composite design models for coordination meetings.
- f. Facilitating use of composite design models in design coordination/clash detection meetings and providing detection reports based on the identification and resolution of all hard and soft collisions.
- g. Ensuring that BIM is used appropriately to test design requirements/criteria for functionality.
- h. Correctly classifying all spaces and equipment in the model to ensure direct comparison with the **PFD** and downstream use for **facility management** as required.
- i. Liaising with Design Team BIM and IT Managers to ensure software is installed and operating properly.
- j. Facilitating BIM technical meetings with discipline Lead BIM Coordinators.
- k. Determining the project BIM geo-reference point(s), and ensuring ALL technical discipline models are properly referenced to the point(s).
- l. Liaising with the client's Facilities Management department to determine specific data and file exchange requirements.
- m. Ensuring that the design **deliverables** specified in the contract are provided in conformance with the formats specified.
- n. Ensuring information for Facility Management (e.g. COBie), as required by the *BIM Project Brief*, is provided for the contractor at nominated submittal milestones.
- o. Ensuring proper BIM derived 2D information for paper printing is provided as required and that it conforms to the **CAD/Drawing Standards**.
- p. Coordinates with the builder to assure the creation of proper BIM final deliverables.
- q. Aligns the requirements and deliverables of different Design Team members irrespective of their contractual lineage, e.g. **DBB** (traditional method), **D&C**, **IPD**.

4.3 Technical (Design) or Trade (Construction) Lead BIM Coordinators

All major technical disciplines/trades (architecture, structural, **MEP**, interior design, etc.) and key trades shall assign an individual to the role of Lead BIM Coordinator to coordinate their work with the entire Design/Construction Team. These individuals shall have the relevant BIM experience required for the complexity of the project and shall have, as a minimum, the following responsibilities for their discipline:

- a. Coordinating technical discipline BIM development, standards, data requirements, etc. as required with the Design Team BIM Manager.
- b. Leading the technical discipline BIM team in its documentation and analysis efforts.
- c. Coordinating clash detection and resolution activities.
- d. Coordinating trade items into the Design BIM (depending on procurement plan).

4.4 Construction BIM Manager

The Construction BMP shall identify the individual assigned to be the Construction BIM Manager. This individual shall have the appropriate level of relevant BIM experience required for the project complexity and procurement delivery strategy. Responsibilities shall include the following:

- a. Taking overall responsibility for the Construction BIM model creation and information developed during construction.
- b. Establishing software protocols for the Construction Team for efficient delivery of project.

- c. Acting as the main point of contact for BIM and related issues between the Construction Team, subcontractors, the client, the Design Team and others as required.
- d. Where a Contractor's BIM Coordination Room is required by the *Project BIM Brief*, providing specifications for it to the client for approval. Ensuring that the Construction Team has necessary hardware and BIM Software properly installed and accessible for project use.
- e. Where 4D BIM is required, ensuring construction sequencing and scheduling activities are integrated with the Construction BIM.
- f. Facilitating use of composite Trade models in construction coordination/clash detection meetings and providing detection reports based on the identification and resolution of all hard and soft collisions.
- g. Communicating with the Design Team, coordinating the data extraction sets required by the construction trades and ensuring that these requests are met.
- h. Coordinating with the Design Team to facilitate the documentation of design changes in the field and updating of the BIM in a timely manner.
- i. Prior to approval and installation, working with Lead Fabrication Modellers to integrate 3D fabrication models with the updated design model to ensure compliance with design intent.
- j. Coordinating update of as-built conditions in the Final Model deliverable.
- k. Coordinating with Design Team and Commissioning Agent to assure Facility Management (e.g. COBie) information, where required, is complete.

5 MODEL SHARING

5.1 Design

- a. The qualifications, experience, and previous success in BIM coordination of the proposed BIM Manager and the Design Team shall be a part of the evaluation criteria for the selection of architecture and engineering (AE) consultants.
- b. The Design Team shall be responsible for providing:
 - A federated BIM fully coordinated and assembled in a model checking software format, e.g. Navisworks, Solibri.
 - Separate copies of each technical discipline model in the original software authoring tool.
 - A 2D plan set, derived from the assembled BIM, for contract bidding.

5.2 Construction Bidding

- a. The qualifications, experience, and previous success in BIM coordination and fabrication of the proposed Construction BIM Manager, Contractor, and major subcontractors to achieve the client's BIM objectives shall be a part of the evaluation criteria for contractor selection.
- b. During bidding, the use of BIM Standards will be announced and reviewed with potential bidders, and then reviewed with the selected Contractor and major subcontractors prior to the start of construction.
- c. The Contractor shall have access to the Design BIM during bidding and construction. The solicitation for bids shall define the legal status of the model to the bidders (**binding, informational, reference, reuse**) by determining the Contract Record Document (the BIM model(s) or the extracted 2D plan set). This decision will be made on the basis of the client's business interests, the maturity of the market for BIM use, and other factors.
- d. Regardless of whether or not the Design BIM model(s) is the Contract Record Document, after a contract is awarded for construction the following shall be provided to the appropriate contractor entities as needed:
 - A fully coordinated and assembled federated BIM in a model checking software format, e.g. Navisworks, Solibri.
 - Coordinated Design BIM model(s) and all native BIM files.

5.3 Construction Phase

- a. It is the Contractor's responsibility to assure that all major trades are modelled and used for clash detection, construction phasing, and installation coordination.
- b. Subcontractor's fabrication models shall be coordinated with the design model. Any conflicts to the design model that need to be made prior to fabrication and construction shall be reported to the Design Team in the

form of a **Request for Information (RFI)**. Clash Reports may also be issued by the Contractor as background information for RFIs and submittals.

6 COLLABORATION PROCEDURES

6.1 Introduction

The success of a BIM enabled project delivery process is highly dependent upon the level at which the entire Design/Construction Team can collaboratively produce and manage information for the duration of the project. This section documents some of the management procedures that can be used for this purpose.

6.2 Collaboration Standards

In the absence of existing documented information management standards mandated by the client, the BIM Team shall nominate the **Collaborative Information Management Standard** to be used on the project. Any amendments considered necessary to these standards must be documented.

When the **Collaborative Information Management Standard** and amendments have been agreed by the BIM Team they shall be adopted and managed for consistent application by the BIM Manager.

At a minimum, the **Collaborative Information Management Standard** shall address the following:

- Lines of responsibility.
- Modes of communication.
- Reporting procedures.
- Approval and Sign-off procedures.
- Information management and exchange protocols.
- Model sharing protocols.
- Model coordination procedures.
- Model and drawing versioning procedures.

6.3 Management of Standards

The *National BIM Guide*, **Collaborative Information Management Standards**, **BIM Modelling Standards** and **CAD/Drawing Standards** can sometimes cover similar subject areas. (See **Modelling Requirements and Requirements for 2D Drawings**.) While areas of overlap or conflict should be identified in the *Project BIM Brief*, it is possible for inconsistencies between the documents to come to light during the project. In these instances the BIM Manager shall be notified immediately. In response, the BIM Manager shall determine, in consultation with the BIM Team (if necessary), which document will take precedence or whether amendments are required and advise the whole BIM Team of the ruling.

6.4 Project Kickoff BIM Standards Orientation

Upon award of the project, the client should facilitate a Pre-Negotiation Project Kickoff Orientation Meeting, which will review all client requirements including those that apply to BIM and answer questions from the Project Team.

6.5 Facilitating BIM Coordination

Face-to-face meetings in which BIM models are used for design review and clash detection/coordination BIM Coordination are the preferred means of facilitating technical discipline coordination. However, different project circumstances will determine the most appropriate approach. Remote means of conducting coordination, such as web conferencing, should only be considered after team members have already established working relationships through face-to-face meetings or when no other practical alternatives exist.

Consider the following means of facilitating BIM coordination and record those selected in the *Project BIM Brief*:

- a. BIM coordination meetings in a suitably equipped room at a location agreed by the BIM Team.
- b. BIM coordination meetings in a **BIM Coordination Room**. Depending on the project procurement strategy, there may be one room or there may be two rooms in succession. During construction, the BIM Coordination Room should be located at or near the construction site to coordinate fabrication models with respective trades. For each BIM Coordination Room, appropriate equipment and tools shall be provided to meet the required outcomes.
- c. BIM coordination meetings using web conferencing (webinar).

The party responsible for providing the facilities shall be determined during the development of the **BIM Management Plan (BMP)**.

7 REQUIREMENTS FOR USING BIM

Consider the following uses of BIM and record those selected in the *Project BIM Brief*. Each should be systematically assessed in relation to project goals and in terms of value they will add.

For those required by the *Project BIM Brief*, the following describe how BIM is to be used for each task noted:

7.1 Project Definition, Planning and Pre-design

7.1.1 Modelling existing conditions

Define the extent of existing conditions to be modelled under the project details in the *Project BIM Brief*, e.g. within property boundaries, site plus immediately adjoining buildings and features, defined precinct. Also define the level of model detail required, e.g. block forms only, detailed modelling, photorealistic modelling. Incorporate reference point defined relative to true north and AHD. Align site with GIS information, northing, easting, etc.

Select from the following options:

- a. Create 3D topo surface from survey information.
- b. Model existing services and subsurface features from available information.
- c. Model geotechnical conditions.
- d. Integrate laser-scanned data about existing buildings, services, vegetation and features.
- e. Subdivide large sites into sites for individual buildings, development phases, etc as required to suit project requirements.

7.1.2 Site analysis

- a. Model planning setbacks, building envelopes, etc.
- b. Map site gradients and drainage patterns.
- c. Map access and circulation patterns.
- d. Model view corridors, privacy patterns (into and out of the site).
- e. Model solar access and shade patterns.
- f. Model climatic influences, wind patterns, etc.

7.1.3 Space and equipment validation

General

Clients are encouraged to use **architectural programming software (APS)**, e.g. Affinity, Codebook, dRofus to compile their space (rooms, etc) and equipment requirements. They are useful aids to brief formulation and the creation of a **Program for Design (PFD)**. To be truly effective these applications must be able to export and import data to and from the model.

APS also provide the BIM Team with the ability to manage, track and report on spaces and equipment in the model during design and construction. This data can also be reused for facility management purposes.

The purpose/s for which floor area will be measured (program validation, leasing, floor space ratio, etc) should be defined before modelling begins as this will determine the appropriate method/s of measurement. See Appendix A: Space Measurement.

Requirements

Space and equipment data shall be captured in the BIM model. All BIM modelling must preserve the field name designations and text values found in the client's program. To do this, the final PFD for the project must be electronically exported from the SPA for import and reuse in BIM. The export can then be imported into the BIM software's "space" tool and equipment data into "elements" or "objects" tools appropriate to the particular BIM software, or the data can be linked in a database external to the BIM software. Spaces and equipment shall be derived from the model and validated against the PFD electronically at each submittal stage.

7.2 Architectural Modelling (Design)

7.2.1 Architecture – spatial and material design models

The timing of the **Level of Development (LOD)** required for elements(s) or systems(s) will be dependent entirely upon the procurement strategy used for the project, as the **deliverables** and their timing will be different for **DBB** than for **D&C** or **IPD**.

The *BIM Object/Element Matrix* shows the evolution of the architectural spatial model as it is refined during the design process as the project progresses toward construction. As materials and components are selected, generic assemblies shall be assigned material properties, sizes, sustainability credits tracked, and other specific component information defined to clearly identify building features such as walls, floors, roofs, doors, and windows. The program space requirements shall be modelled in the spatial model and validated electronically against the **PFD** at each stage of the project and submitted with the required deliverables.

7.2.2 Design visualisation for communication and functional analysis

General

BIM provides the opportunity to build a virtual building and to virtually test that building for functionality during design. This allows project stakeholders to see and understand design solutions that represents reality so they can work towards improving the building design before construction starts. The Design Team is encouraged to find efficiencies and uses for BIM to enhance communication for the project. At a minimum, the model shall be integrated into design reviews, review submittals, and 3D construction documentation views. Areas that would benefit from the use of 3D imagery and fly-throughs during the design process and during construction shall be identified and noted in the BMP(s).

Visualisation tools refer to animated models, fly-throughs, static 3D renderings, 4D process sequencing, and other techniques to assist decisionmaking and comprehension. It should be noted that even though the BIMs contain most of the source information needed for visualisation, they may require further refinement in specific animation and visualisation software to accomplish the intended results.

During design, special consideration should be given to occupant and maintenance issues. Consider the following uses of BIM for communication purposes and record those selected in the *Project BIM Brief*. The purpose, intended users, nature (static or animated), level of detail (outline, photorealistic, etc) and scope of each should also be defined:

Visualisation

- a. Views of the building exterior.
- b. Enhanced visualisations for presentation purposes using photorealistic rendering software and photomontages of the proposed design in the context of the existing street or landscape.
- c. Studies of overshadowing of adjoining properties at times nominated by the planning authority.
- d. Views of the building interior.
- e. Simulated videos of the building, e.g. 'walk bys', 'fly overs', 'walk throughs', 'fly throughs'.

Functional Analysis

- a. Walking distances between major functional spaces.
- b. Sightlines for supervision and security purposes.
- c. Process areas where timing and volume may be problematic, e.g. areas used for queuing, waiting and delivery.
- d. Supply, Processing, & Distribution (SPD) of materials.
- e. Major building equipment clearance reservations for operation, repair, maintenance and replacement using graphics or animations.
- f. Colour coding of floorplates for determining space function types, department locations, circulation zones and floor areas.

7.2.3 Code checking

Use purpose-made model checking software, e.g. Solibri configured for code checking. Define the code and clauses against which the model is to be checked, including applicable standards.

7.2.4 Sustainability evaluation

- a. Define the rating scheme used to evaluate the model, e.g. Green Star Office.
- b. Assign properties to model objects on the basis of the rating scheme criteria, e.g. indoor air quality or link them to an external database to manage them.
- c. Align material quantity methods of measurement and scheduling with those of the rating scheme.

7.3 Structural Modelling and Analysis

- a. Other disciplines shall provide the structural engineer with models that identify the location and extent of all major building elements including required penetrations and setbacks for finishes.
- b. Identify loadbearing and non-loadbearing elements.
- c. Identify loadings by all major plant and equipment.

7.4 MEP Modelling and Analysis

7.4.1 Energy analysis

Energy simulation and life-cycle cost calculations shall be based on information extracted directly from BIM and validated by energy modelling. The models shall be created to a LOD and quality as required to perform an energy analysis appropriate for the phase and decision requirements of the project. When internal spaces are defined, they shall be modelled with internal environment parameters for early MEP design.

Design Teams shall utilise energy modelling and sustainable design software that extracts BIM data to the appropriate file format for the analysis tool.

Consider the following uses of BIM for energy and life cycle cost analysis and record those selected in the *Project BIM Brief*:

- a. Passive design analysis – model the building to allow the use of specialist applications such as Computational Fluid Dynamics (CFD) software.
- b. Mechanical systems analysis – See Virtual Testing and Balancing.
- c. Life Cycle Analysis (LCA) – Use certified analysis applications, e.g. LCA Design. Use material quantity methods of measurement and assign material codes to model objects as required by the application. Obtain LCA data about products and materials from agreed sources using internationally recognised assessment standards. Apply the protocols for the correct use of the data published by the source organisation.

7.4.2 Virtual testing and balancing

Virtual testing and balancing of the architectural model shall be used to support sustainable building systems design and analysis. Room data can be read from the linked architectural model to create mechanical spaces (each space is the same as the room in the architectural model). Multiple spaces are joined to create zones. This data can be used to calculate native heating and cooling analysis that is built into the MEP software or exported using file formats such as gbXML to an external analysis application such as Trane/Trace or US Department of Energy (DOE) based analysis programs. Architecture Engineering (AE) consultants can then bring this data back within the model to check their work. One of the methods is to create a Space/Room schedule that will show calculated air flow vs actual air flow. See **Figure 7.4.2** below. All air flows can be checked for load balance to the terminal box and all the way back to the air handling units. Check with MEP modelling software companies for additional information.

Figure 7.4.2 Calculated vs actual airflow comparison

Space Airflow Schedule				
Number	Name	Calculated Supply Airflow (L/s)	Actual Supply Airflow (L/s)	Airflow Delta (L/s)
System Type	Type	Mark	Flow	
115	Instruction	688	694	6
Supply Air	600x600 – 300x300 neck	SD 1-12-109	170	
Supply Air	600x600 – 300x300 neck	SD 1-12-110	212	
Supply Air	600x600 – 300x300 neck	SD 1-12-111	156	
Supply Air	600x600 – 300x300 neck	SD 1-12-112	156	
116	Conference	274	0	-274
117	Instruction	246	0	-246
118	Electrical	21	0	-21
119	Sprinkler Main	27	0	-27

7.4.3 Lighting analysis

- a. Daylighting and shading – Evaluate options for window and skylight layouts, surface finishes, reflectors, light shelves and window shading to meet briefed requirements.
- b. Artificial lighting – Evaluate options for lighting layouts, lamp types and control systems to meet briefed requirements.
- c. Emergency evacuation lighting – Design layouts to comply with relevant codes and standards.

7.4.4 Other engineering analysis

Fire engineering – Design passive and active fire control systems, e.g. sprinklers to comply with relevant codes and standards.

7.5 Quantity Take-off and Cost Planning

- a. Use agreed specialised model-based applications.
- b. Define the classification system for model elements that will apply for cost management and reporting.
- c. Define the scope of use, e.g.:

- I. Quantity take-off and costing only.
- II. 5D BIM – Costing data linked to 4D BIM, i.e. a model linked to time or scheduling data. Use for generating cash flow reports, etc.

7.6 Construction Models

7.6.1 Clash detection/coordination

General

- It is the Design/Construction Team's responsibility to conduct and manage an adequate and thorough Clash Detection process so that all major interferences between building components will have been detected and resolved before construction. It shall be the goal of the Design/Construction Teams to reduce the number of changes during construction due to major building interferences to zero.
- The BIM Manager shall assemble a composite model from all of the model parts of each design discipline for the purpose of performing a visual check of the building design for spatial and system coordination. Vertical shafts shall also be reviewed to ensure that adequate space has been allocated for all of the vertical mechanical systems (including access space for service and maintenance) and that all of the shafts line up floor to floor. Prior to each scheduled coordination meeting, an updated Clash Report will be issued by the BIM Manager to the technical discipline consultants.
- The approach to coordination/clash detection will depend on the project. On a multistorey project, for example, the models may need to be split on a level by level basis for Mechanical Electrical Plumbing Fire service (MEPF) coordination. If a floor is particularly large, it may also need to be split by zones to reduce file size. Typically, 3D clash detection/coordination continues on a single floor until building systems are fully coordinated, and then continues on the next floor up.
- Coordination software shall be used for assembling the various design models to electronically identify, collectively coordinate resolutions, and track and publish interference reports between all disciplines. The technical disciplines shall be responsible for updating their models to reflect the coordinated resolution.
- The team shall review the model and the Clash Reports in coordination meetings on a regular as-needed (generally weekly) basis throughout the design phases until all spatial and system coordination issues have been resolved.
- During the construction phase, the accuracy of fabrication models shall be verified. Prior to each fabrication submittal for approval, fabrication contractors shall submit their models to the Contractor's BIM Manager for integration and clash detection/coordination and resolution.
- Internal Clash Resolution: Design Consultants and Subcontractors who are responsible for multiple scopes of work are expected to coordinate the clashes between those scopes prior to providing those models to the BIM Manager for spatial and system coordination.
- Spatial Coordination Verification: Verification and tracking of resolved conflicts of all trade coordination issues which could result in variations or site conflicts shall be provided to the client during project milestone dates, and should be fully resolved before bidding.
- For ease of identification during the 3D Clash Detection/Coordination process, elements are to be represented by the colours shown in the ***Clash Detection Colour Coding Standard***.

Minimum requirements for spatial coordination and clash detection

- a. **Architecture + Structural:** Below-grade spaces, proposed floor plates with major penetrations, floor-to-floor heights, beam clearances, heavy utilities locations, floor loads, core and vertical shafts, beam depths and required clearances, soffit-mounted equipment, slab thickness, columns, column caps and seismic bracing. Provide adequate space for construction and maintenance access to structural elements, building equipment, and distribution systems.
- b. **Architecture + MEPF:** Structural and space elements, flow and isolation requirements, proposed functional area configurations, floor-to-floor heights, fire containment, vertical and horizontal transportation. Possible future expansions shall be considered in consultation with the client and shall be clash-free.
- c. **MEPF/HVAC + Architecture, Structure, and Telecommunications:** Main distribution and collection systems, configurations and sizes for piping, duct, conduit, power wiring, fans; diffusers; intakes, large compressors. Clearance reservations for equipment maintenance, filter removal and equipment removal and replacement shall be modelled with the equipment, and sign-off on the adequacy of the space reservations shall be obtained from the **Facility Manager** where one has been appointed.
- d. **Architecture + Life Safety Fire Protection:** Safe zone and fire suppression pipe location, egress paths and exit distance requirements, equipment, and pipe penetrations.
- e. **Major Non HVAC Equipment + Architecture, MEPF, HVAC, Structural:** Major equipment positioning and location requirements, specialist service distribution and waste collection, e.g. medical gases and cryogenic

supply piping, public communications and building controls. This includes major equipment adjacencies and guards, barriers, pipes, venting and air intake locations and other limitations.

- f. **Architecture/HVAC + Interiors:** Merges shall include ductwork and piping + ceilings and Furniture, Fixtures & Equipment (FF&E) + HVAC.
- g. **Space Validation:** There shall be no space gaps. Bounding boxes used to represent room and zone spaces shall match with architectural requirements and data values, and all shall be coordinated with values given in the Program for Design.
- h. **General Model Quality Checking:** All walls shall be properly joined to prevent “space leaks” in areas defined by enclosing walls. Bounding boxes shall not conflict.
- i. **Security:** Security setbacks + structure + site.
- j. **Accessibility Compliance:** Wheelchair pathways and clearances + structure. (If using rules-based model checking software such as Solibri Model Checker, accessibility compliance can be checked automatically.)

7.6.2 Construction system design

BIM shall be used for the following:

- a. Modelling complex building systems such as formwork and scaffolding to improve planning, construction productivity and safety.
- b. Modelling to improve constructability and erection times through the design of modular construction components suitable for off-site construction.

7.6.3 Digital fabrication

The collaborative process can ensure that the knowledge and associated efficiencies of the fabricator are embedded into the Construction Model(s). Nominate in the *Project BIM Brief* which of the following construction trades are to provide 3D fabrication models with parametric model objects:

- a. Structural Steelwork.
- b. Mechanical System Ductwork.
- c. MEP subcontractors (incorporate vendor models if available).
- d. Curtain Walling.
- e. Building Envelope Systems (rain screens, pre-cast panels, glazing systems).
- f. Any additional fabrication models generated by subcontractors.

7.6.4 Planning construction scheduling and sequencing – 4D

For design work that includes sequencing of renovation swing space or master planning for long-term build-out, BIM 4D shall be used to illustrate the phasing plan to interact, communicate, and get approval of the final design and spatial sequencing with the building occupants.

7.6.5 Communication of construction scheduling and sequencing - 4D

The Contractor shall link BIM to the project schedule as a communication method to coordinate with the building users and the **Facility Manager**, where one has been appointed, on logistics that affect existing building operations or require shutdown of any affected facilities and utilities. The animated phasing plan shall address such issues as swing space during construction, parking interruptions, and re-routing of pedestrian/vehicular traffic, or any other construction work that could affect building operations.

It is recommended that the Contractor also use BIM - 4D in schedule planning and communication with the subcontractors and to understand the impact to the construction schedule of other changes during the duration of the project.

7.6.6 Site utilisation planning

Use 4D BIM to model permanent and temporary on-site facilities, equipment and material locations and movements, including deliveries for planning purposes and to communicate on-site activities to site personnel and building occupants.

7.6.7 Lift planning

The model can be used to plan engineered lifts, i.e. the lifting of large or heavy building components and assemblies into place. Lift plan models can be created through collaboration between the structural engineer and experienced site personnel such as the lift supervisor, and used to communicate the lift plan to those involved in its execution. A 3D model communicates the plan clearly to site personnel who may not be proficient in English or in reading 2D plans or written instructions.

Lift plan models shall address the following:

- a. Location of cranes, hoists, rigging, etc.

- b. Location of lifting team members.
- c. Pick up and set down areas.
- d. Lifting paths and load rotations.
- e. Boom angles.
- f. Crane boom and load clearances between other cranes, building elements, obstructions and hazards (power lines, etc).

7.7 Facilities Management/As-built Models

An as-built model with information captured during the design and construction phases of the project can be a valuable resource during the operational phase of the project if data is in an appropriate format. Define facility management requirements to determine what information shall be gathered. Typical uses include:

- a. Space management and tracking – space utilisation, allocation of space to building occupants.
- b. Asset management – allocation and tracking of furniture, fittings and equipment.
- c. Maintenance scheduling.
- d. Building system performance analysis.

As a minimum, facility management information should be provided in a digital form and organised and indexed in a clear, logical manner that allows the information to be easily retrieved by anyone with basic computer skills using readily accessible software.

7.7.1 COBie/commissioning

General

Construction Operations Building Information Exchange (COBie) is a methodology to electronically transfer building information on completion of construction for facilities management purposes. Spreadsheets for some systems are available for download. See www.wbdg.org/resources/cobie.php. Third-party utilities facilitate the automatic creation and transfer of some data between BIM and COBie spreadsheets via **Industry Foundation Class (IFC)** files as an intermediate stage, and some BIM software may include creation of, and data transfer to, the spreadsheet directly without making use of intermediate IFC files. Where possible, automatic means should be used to create and fill in the COBie spreadsheets.

Requirements

The model and facility data for the commissioning, operations and maintenance of the project shall satisfy COBie requirements, and be submitted in compliance with the commissioning requirements. The data expected from BIM for facility handover shall conform to the following standards: **Uniformat**, **OmniClass**, **Geospatial**, **COBie**, and **IFC** standards for building information. COBie data in the form of the COBie Excel Spreadsheet and related commissioning information shall be delivered electronically in formats suitable for integration into the current and/or planned **Computer Aided Facility Management (CAFM)** system, **Computerised Management Maintenance System (CMMS)**, **Integrated Workplace Management System (IWMS)**, **Building Management System (BMS)** or any other system advised by the client.

The Design/Construction Team shall consult their BIM software vendor(s) for the most current COBie utilities. However, the completed COBie worksheets will also contain some information that is entered manually into the electronic file, either because the information currently cannot be conveniently extracted from the BIM or because it does not reside in the BIM.

The Design/Construction Team is encouraged to provide as much information in COBie as is known at the time of the deliverable. The required worksheets in COBie shall be filled out in step with the LOD and Design Phases (See *BIM Object/Element Matrix*).

- The Design/Construction Team(s) shall submit the most current version of the COBie spreadsheet with other required **deliverables** at each Project Phase.
- With construction documentation deliverables, the COBie Type and Component worksheets are required. These fields provide Component Name, Description, and Creation Date. Equipment listed in the **Program for Design (PFD)** exported from the **Architectural Programming Software** shall be noted on the COBie spreadsheet.

7.7.2 Other FM information handover/commissioning systems

General

Where the client and BIM Team determine that use of the COBie system is not appropriate for the project, they shall define the specific information required for facility management purposes and the strategy for delivering it.

Requirements

As a minimum, the development process for the proposed system shall address the following issues:

- a. Identification of facility management information required by end users.
- b. The organisation and indexing of information to facilitate its retrieval by required search criteria.
- c. File formats to be incorporated.
- d. Software applications required to access and/or manage the information.
- e. System features and functionalities required, e.g. ability to update information, create reports in the desired format, ability to integrate with the building's systems, e.g. **Building Management Systems (BMS)**.
- f. Strategy for collecting the required information throughout the project and delivering it to the client at a defined time.

7.7.3 Security assessment and disaster planning

An as-built model can be used to evaluate the physical security and survivability of a facility.

An as-built model can also be a useful emergency response planning tool if provided to emergency services. The model coupled with the Building Management System can be used to identify the nature and location of the problem in the building and the best route to it.

The project team should liaise with local emergency service providers to establish their information requirements and agree emergency protocols.

Record specific uses of BIM for these purposes in the *Project BIM Brief*.

8 3D MODELS, FORMATS, AND MODEL STRUCTURES

8.1 General

The BIM(s) shall consist of objects and elements that represent the actual dimensions of the building elements and the building equipment that will be installed on the project. Before modelling begins, the BIM Manager will work with the Design Team to develop the model and model view extraction structure for all the construction document files to assure coordination between disciplines. This structure shall be provided to the client so that the models can be reconstructed at a later date. BIM coordination requires the following model structure and features.

- a. The BIM Manager shall establish the floor elevation protocol so that the Technical Discipline/Trade BIMs will be modelled at the correct elevation.
- b. Clearance Reservations: All models shall include separate 3D representations of required clearances for all mechanical equipment for repair, maintenance, and replacement, light fixture access, overhead cable tray access, etc. These clearance/access models should be in a separate layer(s) for each trade clearly labelled as such.
- c. The granularity of elements in the model shall correspond with the proposed sequence of the installation at the site (e.g. not one wall element for the entire floor).
- d. All 3D model files submitted for clash detection shall be "clean;" all extraneous 2D references and/or 3D elements shall be stripped from the models.
- e. When emailing notification of file uploads or for any other email correspondence pertaining to the project, all email subject line headings must be prefaced with the acronym for the Project Name.

8.2 Subcontractor Coordination

Prior to installation, the Contractor shall hold trade coordination meetings with subcontractors. The coordinated model will be used to review and optimise scheduling and field installation. Subcontractors shall have individuals attend who can actively engage in the subcontractor coordination process and make schedule commitments.

9 TECHNOLOGY PLATFORM AND SOFTWARE

9.1 Approved BIM Software for Projects

All BIM Software used on the project shall be as documented in the *Project BIM Brief*.

The following criteria shall be used to evaluate the suitability of software for use on the project and any non-compliance with the criteria brought to the attention of the client for approval.

Preference is given to object oriented software applications that comply with current industry **interoperability** standards and are able to be used in a collaborative environment. All software platforms used should be compliant with:

- Model authoring software certified as being suitable for use with the most current version of **Industry Foundation Class (IFC)** file format available at commencement of the project.
- Model authoring software certified as being able to export native files to IFC file format without loss of geometric integrity.
- Commercially available model checking software that provides interoperability between the different software applications.
- Traditional 2D documentation prepared with approved IFC compliant BIM authoring software and plans, elevations, sections, schedules, and details shall be derived and fully coordinated with the coordinated building model. All other documents are to be submitted in compliance with contract requirements.
- BIM based energy analysis software used should support IFC import or be a native BIM model format that is IFC compliant. Energy analysis software selection shall be based upon US Department of Energy (DOE) Recommendations and ANSI/ASHRAE 140-2007 (or latest version) and conform to the Australian Building Code Board (ABCB) Protocol for Building Energy Analysis Software.
- All BIM software support tools used for managing information directly linked to the model, e.g. database applications for managing Room Data Sheets, shall be configured and operated so that the integrity of the model is not compromised.

10 MODELLING REQUIREMENTS

10.1 General

- a. BIM shall be used for all building systems design, development and analysis, including but not limited to architectural, structural, mechanical, electrical, plumbing, and fire suppression, etc, as noted in this manual.
- b. During **Conceptual Design**, **Schematic Design** and **Design Development** Phases, BIM technology shall be used to develop and establish building performance and the basis of design in accordance with the client's standards. The model shall be interoperable with analytic tools including, but not limited to, building envelope, orientation, daylighting, energy consumption, **Building Management System (BMS)**, renewable energy strategies, life cycle cost analysis, and spatial requirements.
- c. Use BIM authoring software element libraries when creating model objects. Model objects shall contain parts and components as opposed to simple 3D Geometry (e.g., walls, doors, windows, railings, stairs, and furniture, etc.).
- d. Model objects shall contain **Industry Foundation Class (IFC)** parameters and associated data applicable to building system requirements. These elements shall support the analytic process including size, material, location, mounting heights, and system information where applicable. As an example, a light fixture may contain several parameters such as energy output requirements, user illumination levels, make, model, manufacturer, and bulb life.
- e. The Contractor shall utilise model geometry and extract graphical information for generating construction administration documents from the Project BIM (**RFIs**, **Superintendent's Instructions**, **Bulletins**, **Variation Orders**, etc). The Contractor shall record as-built conditions in BIM as part of final delivery to the client.
- f. Submittal drawings, calculations and analysis shall be extracted from the coordinated BIM.
- g. Elements, objects and equipment shall be tagged with **Global Unique Identifiers (GUIDs)**.

10.2 Types of Model Elements

Model elements shall be derived from the following sources:

- a. **Manufacturer's Model Elements** Elements created by and acquired from manufacturers often have more information than is prudent to keep in the BIM model; the appropriate level of detail should be retained for the design element. However, embedded performance data shall remain for analysis and specification purposes.
- b. **Custom Created Model Elements** Custom model elements that are created shall utilise appropriate BIM Authoring tool templates to create custom elements. Custom models components need to be assigned as a part and part of a family or group.

10.3 Model Geographical Location

The spatial coordination (coordinates) of the master BIM file shall be set at the beginning of the project. Once established, spatial coordinates shall only be changed by mutual consent of the team and the Client's Project

Manager, with the matter recorded in the meeting minutes and the **BMP**. Once the design coordinate system is agreed upon, any model(s) of existing buildings relevant to the project shall be converted into the coordinate system used for each designed building.

A geo-reference to accurately locate the building within the site and to give it a physical location context at larger scales should be included in the BIM file. The BIM Manager shall geo-reference site plans and building models for site layout surveying and future **Geographic Information System (GIS)** use in accordance with the **Map Grid of Australia (MGA)** and the **Australian Height Datum (AHD)**. Latitude and longitude points for GIS purposes shall also be defined. The BIM file point and latitude/longitude points shall be located at an agreed point on site that is readily accessible during construction and will not be displaced. The MGA Reference will always “read” as 0,0,0 – the project base point will read whatever the distance is from the MGA Reference to the lowest left hand point of the building structural grid.

10.4 Points of Reference

The BIM Manager shall provide a 3D grid for incorporation into the spatial coordination model. This will provide the viewer with a quick point of reference when navigating through the model. Room information shall also be incorporated.

10.5 Requirements for Modelling Space

- a. The method of measurement for floor area adopted for the project will be the defining kernel of space counting procedures for the client and form the basis for the **Program for Design (PFD)**. The method of measurement for floor area shall be defined before modelling begins. See **Appendix A** for **Floor area definitions** and **Space Measurement**.
- b. Space information imported from the **Spatial Programming Application PFD** export shall be the source for space creation in BIM¹.
- c. Areas of 0.5 m² or greater shall be tracked and identified by name, even if those spaces are not listed in the Spatial Programming Application PFD export.
- d. Spatial data shall be generated and associated with bounding elements (walls, doors, windows, floors, columns, ceilings).
- e. The defined method of measurement for floor area shall be used when modelling each functional space in the PFD, using the appropriate space/object BIM tool to capture and carry the information. Spaces shall be represented and broken down into functional spaces (e.g. office areas, amenities, plant rooms) as defined in the PFD even though they may be parts of a larger physical space. A physical space may contain several areas that are treated individually in the PFD spatial program. If two areas have different functional space classifications, even though they are within the same physical space, they shall be modelled as two separate spaces. For example, security checkpoint areas within a lobby shall be modelled as separate non-overlapping spaces. These spaces might also be grouped into a Zone for visualisation and analysis purposes (e.g. for thermal simulation calculations). Users should consult with the BIM-authoring application vendor to learn the recommended method for creating space objects that will be exported to an **Industry Foundation Class (IFC)** BIM.
- f. Space/area schedules and diagrams shall be dynamically updated from the model geometry.
- g. Client Spatial Requirements shall be validated through reports generated from the BIM.

10.6 Meta Data

The BIM model(s) shall carry the following information:

- a. Project ID Number.
- b. Project Name.
- c. Other information (Building GUID, location, discipline owner, etc) necessary to allow the specific software applications being used on the project to function correctly.

10.7 Space Naming and Coding

Each space shall include the following attributes which are to be maintained throughout the Design and Construction BIM models.

- a. Building ID Number.
- b. Wing (where applicable).
- c. Floor (Level).
- d. Department (where applicable).

¹Other sources are program narrative and other directives.

- e. Sub-department (where applicable).
- f. Space Name – English Name & Abbreviation.
- g. Room Number – **Wayfinding** Room Number.
- h. Room Number – Construction Document Number (where applicable. Used on large complex projects for builder use).
- i. Space Code – *Room Code*.
- j. Unique Space Number – **GUID²**
- k. Space Type by Function – **Construction Classification System**.
- l. Space Type by Form – **Construction Classification System**.
- m. Space Measurement – Use the defined method of measurement adopted for the project.

10.8 Equipment Coding

Each individual piece of equipment including mechanical equipment shall include the following attributes and be maintained throughout the Design and Construction BIM models:

- a. Item Name – English Name & Abbreviation.
- b. Item Code – Equipment ID Number³.
- c. Unique Item Number – GUID.
- d. Item Type (by function) – **Construction Classification System**.
- e. Item Tracking Number – Stock identification number (where applicable. For specialist equipment).
- f. Blank field for an equipment type code or other (to come later).
- g. Other data available from the **Spatial Programming application (SPA)** that is accommodated by the **COBie** spreadsheet, where used, and is appropriate to the **LOD** for the submission phase.

10.9 Additional Modelling Standards

In the absence of existing documented modelling standards mandated by the client, the BIM Team shall nominate the **BIM Modelling Standards** to be used on the project. Any amendments considered necessary must be documented.

When the **BIM Modelling Standards** and amendments have been agreed by the BIM Team they shall be adopted and managed for consistent application by the BIM Manager.

At a minimum, the **BIM Modelling Standards** shall address the following:

- Model setup including project templates.
- Team member modelling protocols including definition of authorised uses.
- Model naming conventions.
- View naming conventions.
- System naming conventions (services, etc).
- Element naming conventions (walls, partitions, doors, windows, etc).
- Materials and finishes naming conventions.
- Properties/parameters to be included for model objects.
- Object property/parameter naming conventions.

10.10 Final BIM Deliverables

General

One of the primary benefits of the BIM model for the client is to use it for **Facilities Management** upon Occupancy. Information that matures during the construction process is to be captured in the appropriate models on an on-

² Globally Unique Identifier (GUID). GUIDs must be preserved through generation and regeneration of **IFC** deliverables so that a given object (space, equipment, etc) can be tracked properly. GUIDs are automatically assigned by BIM software. BIM software documentation should be consulted to determine how copied equipment object instances are handled in outputted reports and how they are handled internal to the software.

³ The Stock ID Number will be used in the Spatial Programming Application for associating the correct equipment to the proper room.

going basis throughout the construction phase. The use of these models is a developing methodology, and presently, multiple formats of information are required.

Requirements

At agreed times recorded on the project program, BIM files shall be summated to the client, and shall be cleaned of extraneous “scrap” or “working space” layers, stories, abandoned designs, object creation and testing places, empty layers, and other content which is typically produced in BIM production.

Unless the project procurement strategy realigns these responsibilities, the client shall receive the following:

3D Geometric Deliverables – Construction Coordination Model

The Contractor shall be responsible for providing the client consolidated as-built Model(s) for all building systems. The Model(s) shall be fully coordinated and align with the Design Model for architecture and structure; the required instructions on file/folder setup shall also be included:

1. Contractor – Native file formats of the final consolidated as-built Model(s) for building systems used in the multi-discipline coordination process (version as agreed in **BIM Management Plan (BMP)**).
2. Contractor – **Industry Foundation Class (IFC)** file format of the consolidated building systems models (version as agreed in BIM Management Plan)

3D Geometric Deliverables – Design Intent Model

The Design Team is to ensure that the Design Intent Model remains current with all approved **bulletins** for overall scope. It is NOT expected that product specific information will be added to this model. Provide model information for Architecture and Structure Teams and the required instructions on file/folder setup:

1. Design Team - Native file format(s) of Design Model (version as agreed in BIM Management Plan).
2. Design Team - IFC file format (version as agreed in BIM Management Plan).

Data Deliverables

1. Contractor – Provide a Facility Management spreadsheet or database file, e.g. COBie containing room and product data information described in previous sections of this document.
2. Design Team – Provide room/space data in an agreed format, e.g. COBie to be included in the Contractor database.

2D Deliverables

1. Contractor – Provide As-built drawings in archive standard PDF format with fully bookmarked pages. Minimum standard: PDF/A-1b. Preferred standard: PDF/A-2.
2. Design Team – Produce one printed set of final documents generated from the Design Intent Model.
 - a. In archive standard PDF format with fully bookmarked pages. Minimum standard: PDF/A-1b. Preferred standard: PDF/A-2.
 - b. DWG format (latest current version) with bound views to each sheet.

Submission of Digital Deliverables

All digital **deliverables** are to be submitted on DVD/CD with the data clearly organised and software version(s) labelled.

11 FILE STORAGE AND SECURITY

11.1 Project Folder Structure

Maintaining consistent file naming and structure is critical for referenced (linked) files to function properly across Design Teams and for end users such as facilities managers to retrieve files quickly once the project is complete. For this reason, the Design and Construction Teams shall define a file protocol for the team during the development of the BIM Management Plan (BMP).

- a. **BIM Folders** - BIM Files shall be sorted by model files and sheet files.
 - **Model Files** - Original files from other disciplines should be linked from their discipline folder location and relative path to models. Model file names shall follow file naming convention outlined in the BMP.
 - **Sheet Files** - PDF and native file formats of the most current sheets shall be maintained in this folder and organised with sheet file naming outlined in the **CAD/Drawing Standards**.
- b. **Support Files** - Standard items needed for the project, such as a project specific symbols, applications (lisp, script, etc.), logos and graphics. Project-specific model content can also be placed here.

- c. **Coordination Files** - Files for construction coordination (clash detection) shall be managed by the BIM Manager, and organised by date as the project progresses.
- d. **Other Folders** - Renderings, analyses, environmental rating schemes (e.g. Green Star), etc will have their own folders.

11.2 Data Security

Design Teams shall establish a data security protocol to prevent any possible data corruption, virus “infections,” and data misuse or deliberate damage by their own employees or outside sources. Both the Design Team and Construction Teams shall establish adequate user access rights to prevent data loss or damage during file exchange, maintenance, and archiving.

12 REQUIREMENTS FOR 2D DRAWINGS

12.1 General

2D drawing information for the purposes of assembling a printed set of plans shall be derived from the BIM model(s) to the fullest extent possible. All BIM information shall be fully parametric so that all applicable information regarding fixtures and/or elements can be used to generate schedules. Where required by the client, editable text files shall be attached to fixtures/elements to aid in calculations.

12.2 CAD/Drawing Standards

In the absence of existing documented modelling standards mandated by the client, the BIM Team shall nominate the **CAD/Drawing Standards** to be used on the project. Any amendments considered necessary to these standards must be documented.

When the **CAD/Drawing Standards** and amendments have been agreed by the BIM Team they shall be adopted and managed for consistent application by the BIM Manager.

At a minimum, the **CAD/Drawing Standards** shall address the following:

- Drawing naming conventions.
- Layer naming conventions.
- Sheet sizes.
- Title blocks.
- Cross-referencing.
- Drawing scales.
- Linetypes and line weights.
- Gridlines.
- Dimensioning.
- Typefaces.
- Annotations and keynoting.
- Labelling and tagging.
- Abbreviations.
- Symbols.
- Representation of materials and finishes.
- Schedules.
- Legends.

13 GLOSSARY

4D BIM A 3D model linked to time or scheduling data. Model objects and elements with this data attached can be used for construction scheduling analysis and management. It can also be used to create animations of project construction processes.

5D BIM A 4D BIM linked to cost data. The time data adds another dimension to cost data, allowing expenditure to be mapped against the project program for cash flow analysis, etc.

AE, AEC, AECFM Abbreviations for Architect/Engineer, Architect/Engineer/Contractor, Architect/Engineer/Contractor/Facility Manager.

Architectural Programming Software (APS) A software application (based on a database) used to analyse and manage data about the spatial requirements of a building (room function type, required proximities to other functions, building service requirements, floor area, etc). It is also used to generate a spatial **Program for Design**, or brief, for a project and to assess design proposals against the brief.

Australian Height Datum (AHD) The datum used for the determination of elevation in Australia. The determination used a national network of benchmarks and tide gauges and set Mean High Water as zero elevation.

Binding See **Legal status of the Design Model to construction**

BIM Coordination Room A purpose-designed room set up to facilitate the coordination of digital models by members of the BIM Team. It includes IT infrastructure such as cabling, projectors and/or Smart Boards that allow the room's occupants to view models together for coordination, collaborative design, etc.

BIM Management Plan (BMP) A formal document that defines how the project will be executed, monitored and controlled with regard to BIM. A BMP is developed at project initiation to provide a master information/data management plan and assignment of roles and responsibilities for model creation and data integration throughout the project. BMP is used in preference to BIM Execution Plan in the *Guide* because it conveys a broader scope.

Building Information Management (Data Definition) Building Information Management supports the data standards and data requirements for BIM use. Data continuity allows for the reliable exchange of information in a context where both sender and receiver understand the information.⁴

Building Information Model (BIM) (Product) An object-based digital representation of the physical and functional characteristics of a facility. The Building Information Model serves as a shared knowledge resource for information about a facility, forming a reliable basis for decisions during its lifecycle from inception onward.⁵

Building Information Modelling (BIM) (Process) A collection of defined model uses, workflows, and modelling methods used to achieve specific, repeatable, and reliable information results from the model. Modelling methods affect the quality of the information generated from the model. When and why a model is used and shared impacts the effective and efficient use of BIM for desired project outcomes and decision support.

Building Management System (BMS) A network of integrated computer components that is used to monitor and control a wide range of building operations such as **HVAC**, security/access control, lighting, energy management, maintenance management, and fire safety control.

Bulletin A brief update, report or advisory note on an issue circulated to members of the project team.

CAD Computer Aided Design. A geometric/symbol based computer drawing system that replicates hand drawing techniques.

Casework Cabinetry, joinery items.

Computer Aided Facility Management (CAFM) An IT system that supports Facility Management administration. CAFM systems focus on space management issues including the allocation, amount and location of spaces. They also include owner, employee, and cost information. A Computerised Maintenance Management System (CMMS) focuses on facility maintenance and is often part of CAFM. CMMS can manage asset information, maintenance history, equipment documentation, fleet maintenance and staff and subcontractor activities. CAFM and CMMS are often used interchangeably, and for most practical purposes there is little difference between the two systems. See also **Integrated Workplace Management System (IWMS)**.

Computerised Management Maintenance System (CMMS) See above.

CFD Computational Fluid Dynamics. A branch of fluid mechanics that uses computer programs to simulate the behaviour of fluids and gases when interacting with surfaces. In an architectural context CFD is used to analyse airflows around buildings, ventilation patterns, stack effects in multistorey buildings, fire/smoke behaviour, etc.

Conceptual Design The phase of the design process in which the overall scope and nature of the project is determined in response to the site, planning considerations and the client's brief, budget and program.

⁴ *Semantic Interoperability*

⁵ *National BIM Standards BIM product definition*

Construction BIM Management Plan A BIM Management Plan for the construction phase of a project.

Construction Operations Building Information Exchange (COBie) A system for capturing information during the design and construction of projects that can be used for Facility Management purposes including operation and maintenance. A key element of the system is a preformatted Excel spreadsheet used for recording this information. COBie eliminates the current process of transferring massive amounts of paper documents to facility operators after construction has been completed. COBie eliminates the need for as-built data capture after building handover and helps to reduce operational costs.

Deliverables The product of engineering and design efforts to be delivered to the client as digital files and/or printed documents. Typically, this would be the concept submittal and the corrected final design. A deliverable may have multiple phases.

Design and Construct (D&C) The project procurement method in which the client enters into one contract for the design and construction of a building or project with an organisation, generally based on a building company which provides all project management, design, construction and project delivery services.

Design-Bid-Build (DBB) The project procurement method in which the client enters into separate contracts for the design and construction of a building or project. Design and documentation services are generally provided by a professional design consultancy, the documents are used for bidding (tendering) purposes and the successful bidder, generally a building company, enters into a contract with the client to build the project. Often referred to as the 'traditional' method of procurement.

Design BIM Management Plan A BIM Management Plan for the design phases of a project.

Design Development The phase of the design process in which the general relationships represented in the schematic design phase are resolved in more detail. During this phase the dimensions of all major elements are defined and forms of construction finalised.

DOE US Department of Energy.

Facility Management (FM) The process of managing and maintaining the efficient operation of facilities including buildings, properties and infrastructure. The term is also applied to the discipline concerned with this process.

Facility Manager A person responsible for the facility management of buildings, properties or infrastructure.

FF&E Furniture, Fixtures & Equipment.

Geographic Information System (GIS) A system that integrates hardware, software, and data for capturing, managing, analysing, and displaying all forms of geographically referenced information.

gbXML Green Building Extensible Markup Language (XML). A digital file format for exchanging sustainability information in simulation applications.

Globally Unique Identifier (GUID) A unique code identifying each object/space. A GUID should not be confused with "code" in "room code," "equipment code," or "space code." The GUID assigned by the BIM authoring tool persists through room name changes and various other modifications, allowing the object/space to be tracked throughout the project execution process.

HVAC Heating, Ventilation and Air Conditioning.

Industry Foundation Class (IFC) A system of defining and representing standard architectural and construction-related graphic and non-graphic data as 3D virtual objects⁶ to allow data exchange among BIM tools, cost estimation systems, and other construction-related applications in a way that preserves ability to perform analysis on those objects as they move from one BIM system to another. IFC files saved or exported from BIM-authoring software can be used for the following tasks:⁷

- Coordination of BIM models and related design disciplines.
- Clash detection.
- Rules-based checking.
- Building Code compliance.
- Sharing models between different BIM-authoring softwares.
- COBie data derived from BIM models.
- Energy testing data derived from BIM models.
- Systems simulation.

Informational See **Legal status of the Design Model to construction**

⁶ IFC also sometimes refers to its non-proprietary file extension, "IFC."

⁷ As of May 2009, IFC2x4 has its feature set frozen and is concluding the beta-1 test phase.

Integrated Project Delivery (IPD) The project procurement method in which the client enters into a contract with a number of organisations including design consultants and building contractors at the earliest stages of the project to create an integrated team. It is characterised by an expectation that the team will work collaboratively to deliver a product that meets the client's requirements.

Integrated Workplace Management System (IWMS) An enterprise-class software platform that integrates five key components of functionality, operated from a single technology platform and database repository: real estate management, project management, facilities and space management, maintenance management, and environmental sustainability.

Interoperability The Institute of Electrical and Electronics Engineers defines interoperability⁸ as "the ability of two or more systems or components to exchange information and to use the information that has been exchanged." James A. O'Brien and George M. Marakas, authors of *Management Information Systems*, further define interoperability as "being able to accomplish end-user applications using different types of computer systems, operating systems, and application software, interconnected by different types of local and wide area networks." Semantic interoperability refers to the ability to interpret the information exchanged automatically to produce results that are deemed useful by the end users of both systems.

Life Cycle Analysis (LCA). The whole-of-life impact of various initiatives on the environment. In an architectural context LCA is concerned with the impact of the construction and operation of buildings on the environment. This includes assessing the sustainability of building materials (embodied energy, potential for recycling or reuse, etc).

Lead BIM Coordinator A person who performs an intermediary role between the BIM Manager and the modelling team. He/she implements the BIM Manager's modelling standards and protocols and deals with the day-to-day coordination of team members to achieve project goals.

Legal status of the Design Model to construction:

- **Binding:** Imposing a legal (contractual) obligation between the author/s and recipient/s. Used in this context to mean a Design Model that represents what has to be constructed under the terms of the contract.
- **Informational:** A Design Model that conveys non-binding information relevant to the project that may be useful to its recipient/s. No formal claims are made about its accuracy and it is provided on an 'as is' basis.
- **Reference:** A Design Model that is intended to be used for 'read-only' purposes such as recording model development at different stages of the project or clash detection. Once Design Models are designated 'Reference', they shall not be edited further. Reference Design Models can be used as the basis for bid preparation but cannot form part of the contract documents. A model has to be designated 'Binding' for this purpose. Reference models shall be sufficiently accurate for their intended purpose.
- **Reuse:** A Design Model authorised by its authors for modification or further development by its recipients.

Level of Development (LOD)

The American Institute of Architects *Document E202 – 2008 Building Information Modeling protocol Exhibit* defines Level of Development as follows: "The level(s) of Development (LOD) describes the level of completeness to which a Model Element is developed". It describes the steps through which a BIM element can logically progress from the lowest level of conceptual approximation to the highest level of representational precision. The document defines 5 LODs as described below. Each subsequent level builds on the previous level and includes all the characteristics of the previous levels.

The levels defined (with associated content requirements) are:

- **LOD 100 Conceptual:** Overall building massing indicative of area, height, volume, location and orientation may be modelled in three dimensions or represented by other data.
- **LOD 200 Approximate geometry:** Model Elements are modelled as generalised systems or assemblies with approximate quantities, size, shape, location and orientation. Non-geometric information may also be attached to model Elements.
- **LOD 300 Precise geometry:** Model Elements are modelled as specific assemblies accurate in terms of quantity, size, shape, location and orientation. Non-geometric information may also be attached to model Elements.
- **LOD 400 Fabrication:** Model Elements are modelled as specific assemblies accurate in terms of quantity, size, shape, location and orientation with complete fabrication, assembly and detailing information. Non-geometric information may also be attached to model Elements.
- **LOD 500 As-built:** Model Elements are modelled as constructed assemblies actual and accurate in terms of quantity, size, shape, location and orientation. Non-geometric information may also be attached to model Elements.

⁸ Institute of Electrical and Electronics Engineers. IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries. New York, NY: 1990.

Level of Development, by definition, applies to individual Model Elements. When used to describe the BIM model as a whole it is generally taken that all individual Model Elements are of at least that LOD. In practice, strict consistency may not be necessary. A collaboration matrix or Model Progression Specification, as described in *Document E202*, provides a means of specifying the various LODs required for Model Elements at each phase of the project.

Map Grid of Australia (MGA) A coordinate system based on the Universal Transverse Mercator projection and the Geocentric Datum of Australia 1994. The unit of measure is the metre.

Mechanical Electrical Plumbing (MEP) Referring to this group of building services or the engineering disciplines associated with them.

Mechanical Electrical Plumbing Fire (MEPF) Referring to these building services or the engineering disciplines.

Model View Definition (MVD) An IFC View Definition, or Model View Definition, defines a subset of the IFC schema that is needed to satisfy one or many Exchange Requirements of the AEC industry. A MVD defines a subset of the IFC Schema providing implementation guidance for all IFC concepts (classes, attributes, relationships, property sets, quantity definitions, etc.) used within this subset. It thereby represents the software requirement specification for the implementation of an IFC interface to satisfy the exchange requirements.

NATSPEC The Australian National Building Specification system. Used in this document to describe the worksection classification system used to organise it, or the name of the organisation that produces it.

OmniClass The OmniClass Construction Classification System is a classification system for the construction industry, developed by the Construction Standards Institute (CSI) and is used as a classification structure for electronic databases. As the basis of its tables, OmniClass incorporates other existing systems currently in use, including *MasterFormat™* for work results, *UniFormat* for elements, and EPIC (Electronic Product Information Cooperation) for structuring products.

Program for Design (PFD) A formal quantitative schedule of spaces and fixtures, furniture and equipment that informs the design process. A detailed development of the design brief. Derived from analysis of the client's brief, design guidelines and design assessment criteria. It can be manually compiled or generated with the assistance of purpose designed Architectural Programming Software.

Progress BIMs BIM models other than those specified in **Final BIM Deliverables** to be provided at specified milestones in the project program to demonstrate or record progress. They can be used as a design tool by the design or construction teams only or form part of the deliverables for the client. If Progress BIMs are required, they shall be specified in the BIM Management Plan (BMP) and the following details for each included:

- Program milestone.
- Level of Development.
- Features to be modelled.
- Recipient, e.g. Design Team only, client.

The same delivery requirements for 3D Geometric Deliverables specified in **Final BIM Deliverables** apply to Progress BIMs unless otherwise noted in the BMP.

Reference See **Legal status of the Design Model to construction**

Request for Information (RFI) A documented request for information on a matter from one party to another. They are usually managed through formal procedures agreed by members of the project team.

Reuse See **Legal status of the Design Model to construction**

Schematic Design The phase of the design process in which the general arrangement of the project, including indicative room sizes and layout, overall form of the building/s and its/their relationship to the site, is determined.

SPD Supply, Processing and Distribution of materials.

Submission Instructions Written instructions outlining the submissions to be made throughout a project, including their format, timing and who is to submit them. They can be part of the project brief.

Superintendent's Instruction (SI) A written instruction, or a written confirmation of a verbal instruction, from the Superintendent nominated in the contract to the contractor. Generally confined to items that represent a variation to the contract. Also referred to as Architect's Instructions, depending on the term used in the contract.

Unifomat A classification system for building elements (including designed elements) that forms the basis of Table 21 of the Omniclass system. A product of the Construction Specifications Institute (CSI) and Construction Specifications Canada (CSC).

Variation Order (VO) A written authorisation issued by the Superintendent or client's agent to the contractor to proceed with work which will result in a variation to the contract sum. Generally issued after the receipt of a quotation for the variation.

Wayfinding All of the methods which people use to orient themselves in physical space and navigate from place to place, i.e. find their way.

14 REFERENCE DOCUMENTS

The following standards and documents are cited in the National BIM Guide

ASTM E2807 2011 Standard Specification for 3D Imaging Data Exchange, Version 1.0

Book of Areas Australian Institute of Quantity Surveyors (AIQS)

Construction Operations Building Information Exchange (COBie) National Institute of Building Sciences

Document E202 – 2008 Building Information Modelling Protocol Exhibit American Institute of Architects

MasterFormat™ Construction Specifications Institute (CSI) and Construction Specifications Canada (CSC)

Method of Measurement: Commercial Property Council of Australia 2008.

Method of Measurement: Domestic Property Council of Australia 2008.

OmniClass Secretariat for the Omniclass Development Committee

Uniformat Construction Specifications Institute (CSI) and Construction Specifications Canada (CSC)

VA BIM Guide United States Department of Veteran Affairs 2010

15 APPENDIX A: SPACE MEASUREMENT

15.1 Floor Area

The purpose/s for which floor area will be measured should be defined before modelling begins as this will determine the appropriate method/s of measurement.

Areas of buildings are generally measured for three purposes:

1. For planning and building operations.
2. For tenancy and leasing definition.
3. For analysis and comparison of buildings.

Planning authorities throughout Australia have individual requirements for the measurement of areas for town planning and building application purposes. Since these can differ between States and Territories and between individual Councils and Authorities, the basis of measurement applicable to each project should be checked with the relevant authority.

Measurement of tenancy and lease areas are generally calculated in accordance with the *Method of Measurement: Commercial* or *Method of Measurement: Domestic* published by the Property Council of Australia.

The following floor area definitions are for the analysis and comparison of buildings and are abridged versions of those found in the Australian Institute of Quantity Surveyors (AIQS) *Book of Areas*. Refer to it for full definitions. The Unit of Measurement for each is the Square Metre (m²).

Building Area (BA) The total area of the building at all building floor levels measured between the outside faces of enclosing walls.

Gross Floor Area (GFA) The sum of the 'fully enclosed covered area' and unenclosed covered area'.

Fully enclosed covered area (FECA) is the sum of all such areas at all building floor levels, including basements, computed by measuring from the normal inside face of exterior walls.

Unenclosed covered area (UECA) is the sum of all such areas at all building levels, including roofed balconies, open verandas or attached open covered ways alongside buildings.

Usable Floor Area (UFA) The sum of the floor areas measured at floor level from the general inside face of walls of all the interior spaces related to the primary function of the building. The UFA excludes columns, service ducts, service plant rooms, lifts, voids, amenities, service areas and common areas, e.g. shared areas such as foyers and corridors.

15.2 Measurement Procedures

Adopt a method of measuring area that synchronises in a practical way with major BIM authoring tools.

Area: BIM authoring tools allow areas to be automatically delineated based on the footprint of surrounding walls which create a polygon, or based on a manually drawn polygon. The areas of contained columns can be automatically subtracted in a flexible, size-dependent way, to yield a usable area meeting the client's definition.

Manual methods for delineating areas are required to allow centrelines of adjacent spaces to be used while allowing the corridor face to bound the space on the corridor side.

Volume: Space volume is determined manually and geometrically by specifying an area footprint and assigning a height to it. Volume calculations in BIM do not change any existing volume guidelines found in the client's documentation.

Volumetric calculations may require some adjustments in how the BIM is constructed and how space is delineated, in particular with regard to multistorey spaces, and cavity walls. As with BIM tools that create and place building elements, BIM "space objects" must be used in the way prescribed by the BIM authoring software if volumes are to be correct, if equipment location reports are to be correct, and if the exported IFC model for analysis is to yield correct results. For example, the count of occupied space volume under sloped building elements is typically adjusted to accommodate concepts of usable space. On the other hand, equipment can occupy the space otherwise not counted as usable. The Design Team may find that for correct reporting purposes, different categories of space enclosing nearly the same volumes will have to be defined in the BIM and reported out judiciously.