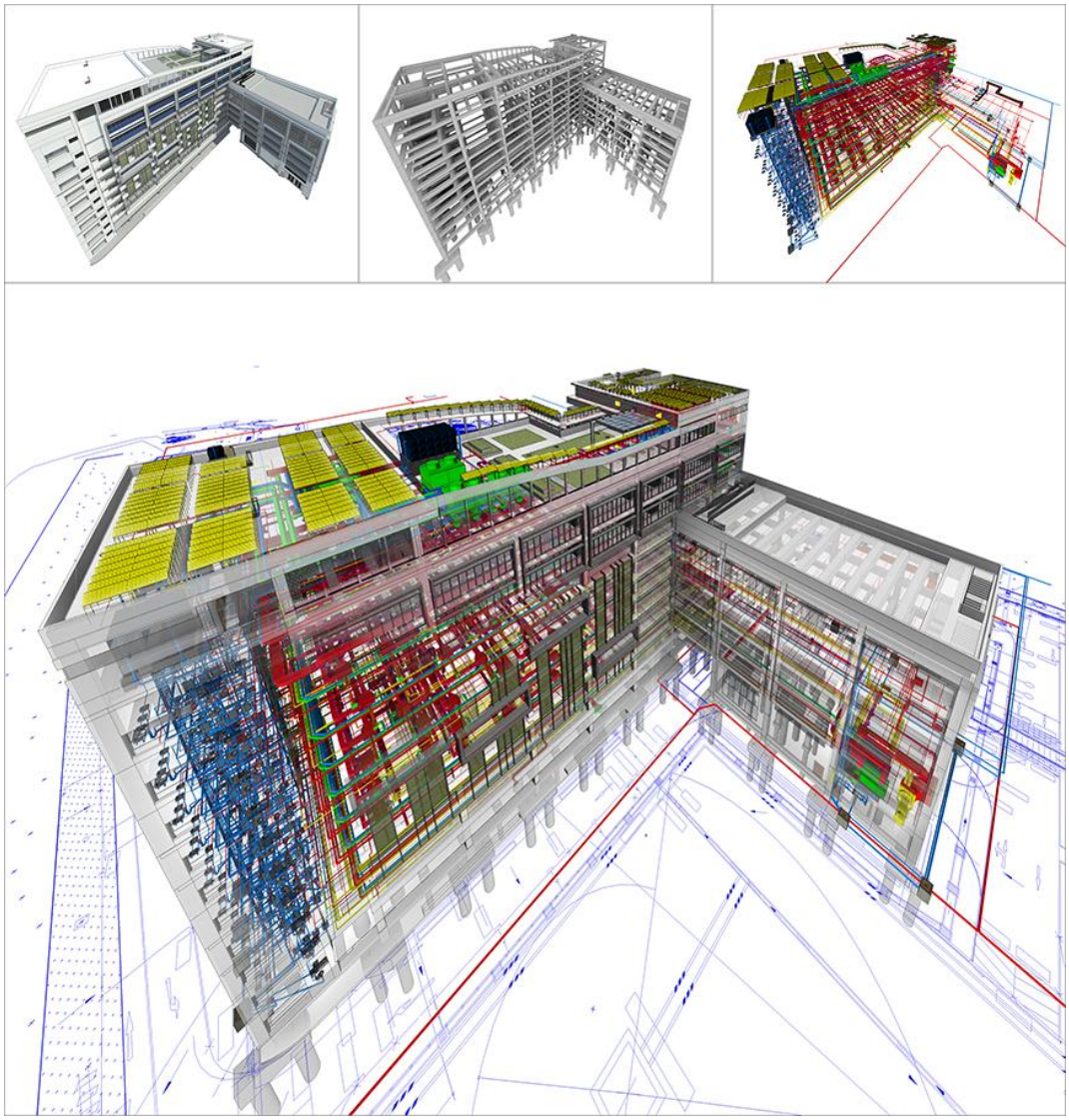
Building and Construction Authority

Singapore BIM Guide

Version 2



BCA acknowledges the leadership provided by the BIM Steering Committee in support of the production of the Singapore BIM Guide.

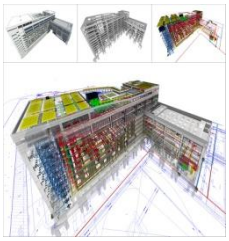
The Singapore BIM Guide has been drafted by the BIM Guide Workgroup on behalf of BCA and the BIM Steering Committee.

©Building and Construction Authority 2013

Building and Construction Authority
5 Maxwell Road
#16-00 Tower Block MND Complex
Singapore 059110
www.bca.gov.sg

First published May 2012
2nd Version August 2013

While every effort has been made to ensure the accuracy and quality of information contained in this publication, the Building and Construction Authority, its employees, agents or industry partners can take no responsibility for the subsequent use of this information, nor for any errors or omissions that it may contain.



Cover image and design courtesy of RSP Architects Planners & Engineers (Pte) Ltd and the BCA Academy of the Built Environment.

Contents

CEO's Message iii

BIM STEERING COMMITTEE iv

BIM GUIDE WORKGROUP vi

1 INTRODUCTION 1

BIM Deliverables 1

BIM Processes (Modelling and Collaboration Procedures) 1

BIM Professionals (BIM Manager and BIM Coordinator) 2

2 BIM EXECUTION PLAN 3

3 BIM DELIVERABLES 5

3.1 BIM Elements 5

3.2 Attributes of BIM Elements 6

3.2.1 Model Progression 6

3.2.2 BIM vs 2D Practices 8

3.3 BIM Objective & Responsibility Matrix 11

3.3.1 Model Author 12

3.3.2 Model Users 12

3.4 Compensation Expectations 13

3.5 Other Additional Value-added BIM Services 14

4. BIM Modelling and Collaboration Procedures 15

4.1 Individual Discipline Modelling 16

4.1.1 Modelling Guidelines for BIM Elements 16

4.1.2 Modelling Guidelines for Regulatory Submission 16

4.1.3 Model Orientation 16

4.1.4 Model Division and Structure 17

4.1.5 Revision Management 17

4.2 Cross-disciplinary Model Coordination 17

4.2.1 Types of Model Coordination 20
4.3 Model & Documentation Production 21
4.3.1 Publishing 2D Drawings 21
4.3.2 BIM Exchange Formats 22
4.3.3 Documentation after Coordination 22
4.4 Data Security & Saving 22
4.5 Quality Assurance and Quality Control 23
4.6 Workflow of Design-Build Projects 24
4.7 Workflow of Design-Bid-Build Projects 24
5 BIM Professionals 25
References 27
Appendix A – Typical BIM Elements by Discipline 28
(I) Architectural BIM Elements 28
(II) Structural BIM Elements 29
(III) Civil BIM Elements 30
(IV) ACMV BIM Elements 31
(V) Plumbing and Sanitary BIM Elements 32
(VI) Fire Protection BIM Elements 33
(VII) Electrical BIM Elements 33
(VIII) Gas BIM Elements 34
Appendix B – BIM Objective & Responsibility Matrix (Basic) 35
Appendix C – BIM Modelling Guidelines 41
(I) Overview 42
(II) Quality Assurance 43
(III) Architectural BIM Modelling Guidelines 44
(IV) Structural BIM Modelling Guidelines 48
(V) MEP BIM Modelling Guidelines 52

CEO's Message



Dear readers,

Building Information Modelling (BIM) has gained much traction in recent years as digital construction technology that will fundamentally transform the building and construction industry practice in the delivery of an excellent built environment. It is a game changing technology that will improve the construction productivity as well as the level of integration and collaboration across the various disciplines in the construction value chain. It is therefore important for the industry to embrace the technology with clarity.

The Singapore BIM Guide Version 2 is part of the industry's efforts to demystify BIM and to give clarity on the requirement of BIM usage at different stages of a project.

Under the leadership of the BIM Steering Committee chaired by Er Lee Chuan Seng, Emeritus Chairman, Beca Carter, and comprising of leaders in BIM, the BIM Guide Workgroup has contributed much time and effort to compile the various best practices to make this Guide possible over a short span of time. We would like to thank them for their contribution.

We hope that every BIM user can truly reap the benefits of BIM by integrating it into his/her day-to-day workflow – from feasibility study to facility management. We hope that BIM users can use these guides as a platform to jumpstart their BIM adoption, before they leap to greater heights, innovating and transforming their workflow.

BIM is a journey. We envisage that it will grow with time and will inspire more advanced and innovative use of BIM. I would like to encourage all BIM practitioners to join in this industry effort to grow this Guide into a wealth of BIM knowledge.

Dr John Keung

BIM STEERING COMMITTEE

The BIM Steering Committee (2011 - 2013) comprises of the following:

CHAIRMAN

ER LEE CHUAN SENG
Emeritus Chairman, Beca Asia Holdings Pte Ltd

DEPUTY CHAIRMEN

ER LAM SIEW WAH
Deputy CEO (Industry Development), Building and Construction Authority

ER LAI HUEN POH
Board Member, BCA; Managing Director, RSP Architects Planners & Engineers (Pte) Limited

INDUSTRY ASSOCIATIONS

ASSOCIATION OF CONSULTING ENGINEERS SINGAPORE (ACES)

ER LIM PENG HONG
Imm. Past President; Managing Director, PH Consulting Pte Ltd

ER LOH WAH KAY
Hon Treasurer; Principal Consultant, M & P Consulting Engineers (S) Pte Ltd

BUILDINGSMART SINGAPORE

ER TEO KONG POON
President; Senior Director, Seagate Technology International

INSTITUTE OF ENGINEERS SINGAPORE (IES)

ER JOSEPH TOH
Council Member; Director, Beca Carter Hollings & Ferner (SEA) Pte Ltd

ER CHAN EWE JIN
Representative; Managing Director, Ecas-Ej Consultants Pte Ltd

REAL ESTATE DEVELOPERS' ASSOCIATION OF SINGAPORE (REDAS)

MR CHNG CHEE BEOW
Committee Member; Executive Director, CEL Development Pte Ltd

MS QUEK CHAY HOON
Representative; Property Director, Wing Tai Property Management Pte Ltd

SINGAPORE CONTRACTORS ASSOCIATION LIMITED (SCAL)

MR DOMINIC CHOY
Secretary-General; GM (Projects), Hexacon Construction Pte Limited

MR WONG KEAM TONG
Representative; Senior Technical Manager, Woh Hup (Pte) Ltd

MR YAP HONG KENG
Representative; BIM Manager, Hexacon Construction Pte Limited

SINGAPORE INSTITUTE OF ARCHITECTS (SIA)

MR WILLIAM LAU
1st VP; Principal, William Lau Architects

MR BEN THUM
Representative; Innovation Director, SIACAD Pte Limited

MR LOH JU-HON
Council Member; Director, RDC Architects Pte Ltd

MR TAI LEE SIANG
Representative; Group Managing Director, Ong & Ong Pte Limited

SINGAPORE INSTITUTE OF SURVEYORS AND VALUERS (SISV)

PROF TOR YAM KHOON
Div 2nd VP (LS); Associate Professorial Fellow, Nanyang Technological University

MS LOH SUAT YEN
Div Representative (LS); Principal Land Surveyor, Housing & Development Board

MR KHOO SZE BOON
Div 1st VP (QS); Executive Director, Langdon & Seah Singapore Pte Limited

MR GOH NGAN HONG
Div 2nd VP (QS); Senior Consultant, CPG Consultants Pte Limited

MR EUGENE SEAH
Div Hon Treasurer (QS); Deputy Chairman, Langdon & Seah Singapore Pte Limited

MS EVELYN CHANG
Executive Director

GOVERNMENT PROCUREMENT ENTITIES

HOUSING & DEVELOPMENT BOARD (HDB)

MR SNG CHENG KEH
Deputy CEO (Building)

MR THOMAS SEOW
Group Director

MR LARRY CHENG
Director / Sr Principal Architect, HDB Building Research Institute

MR MUHAMMED FIRDAUS MAYATIM
Engineer

LAND TRANSPORT AUTHORITY (LTA)

ER PAUL FOK
Group Director / Chief Engineer

ER NEO BIAN HONG
Deputy Group Director

MDM WU FENG CHU
Senior Manager

MINISTRY OF EDUCATION (MOE)

MR ENG WEE TONG
Deputy Director

MR TAN CHEE CHUEN
Senior Head

MS CARMEN HONG
Senior Head

SINGAPORE LAND AUTHORITY (SLA)

DR VICTOR KHOO
Deputy Director (Land Survey)

MR DERICK TAN
Principal Surveyor (Land Survey)

MR SOON KEAN HUAT
Senior Surveyor (Land Survey)

REGULATORY AGENCIES

BUILDING AND CONSTRUCTION AUTHORITY (BCA)

ER CHEW KEAT CHUAN
Group Director

ER THANABAL KALIANNAN
Director

MR CHENG TAI FATT
Deputy Managing Director, BCA Academy of the Built Environment

DR TAN KEE WEE
Director, Centre of Construction IT

FIRE SAFETY AND SHELTER DEPARTMENT (FSSD)

MR BOO GEOK KWANG
Director

MR LEE WEE KEONG
Assistant Director

MR HENG CHAI LIANG
Assistant Director

URBAN REDEVELOPMENT AUTHORITY (URA)

MR PETER TAN
Senior Director

MR LOH TECK HEE
Director

MR CHIN KOON FUN
Principal Planner

OTHERS

BIM MANAGERS FORUM

MR JOSEPH SIM
Shimizu Corporation Singapore

ER LIEW VE KOON
P&T Consultants Pte Ltd

MR DANIELS CHANDRA
Ong & Ong Pte Ltd

MR ASHWIN MURARI
3PA International

ER TAN LING LING
AECOM SINGAPORE PTE LTD

MS ANG KOOI FUNG
Woh Hup (Pte) Ltd

MR WONG HAO JAN
DP Architects Pte Ltd

CONSTRUCTION INDUSTRY IT STANDARDS TECHNICAL COMMITTEE (CITC)

MR EDWARD D'SILVA
Chairman

LEGAL & CONTRACTUAL WORKGROUP

MR PAUL WONG
Chairman; Partner, Rodyk & Davidson LLP

BIM GUIDE WORKGROUP

The BIM Guide Workgroup comprises of the following:

CO - CHAIRMEN

MR CHNG CHEE BEOW
Committee Member; Executive Director, CEL Development Pte Ltd

MR LARRY CHENG
Director / Sr Principal Architect, HDB Building Research Institute

MEMBERS

MR LAWRENCE LEONG
Manager, City Developments Limited

MS TAY SEOK CHENG
Senior Manager, City Developments Limited

MR LEE YEW KWUNG
Senior VP, CapitaLand Residential Singapore Pte Limited

MR GOH KOK WEE
Project Manager, CapitaLand Residential Singapore Pte Limited

MR LAWRENCE LEONG
Manager, City Developments Limited

MS NINA TEO
IT Manager, CapitaLand

MR MARK TUNG
Senior Manager, Land Transport Authority

MS GERMAINE CHUNG
Senior Head, Ministry of Education

MDM CARMEN HONG
Infrastructure Executive, Ministry of Education

MR ASOKAN S/O TK
Senior Manager, Defence Science and Technology Agency

RESOURCE PERSONS

ARCHITECTURE

MS GRACE LIM
Senior CAD / BIM Manager, AEDAS Pte Limited

MR VINCENT KOO
Managing Director, DCA Architects Pte Limited

MR HOO CHUEN PIEW
Director, DP Architects Pte Limited

MR DANIELS CHANDRA
Director, BIM, Ong & Ong Pte Limited

MDM VIVIEN HENG
Director, RSP Architects Planners & Engineers (Pte) Limited

MR KESARI PAYNENI
BIM Manager, RSP Architects Planners & Engineers (Pte) Limited

CIVIL & STRUCTURAL ENGINEERING

ER LAUW SU WEE
Managing Director, LSW Consulting Engineers Pte Limited

MR TEE KOK KUANG
IT Administrator, LSW Consulting Engineers Pte Limited

MR PHIL LAZARUS
Senior BIM Specialist, Arup Singapore Pte Limited

MECHANICAL & ELECTRICAL ENGINEERING

ER BRYAN CHIN
Senior Associate Director, Beca

ER TIMMY MOK
Senior Principal, T. Y. Lin International Pte Limited

ER LEONG CHENG WEE
Director, Method Engineering Pte Limited

MS SUM YUIT MEI
Planning Manager, Squire Mech Pte Limited

QUANTITY SURVEYING

MR SILAS LOH
Partner, Rider Levett Bucknall LLP

MS EUGENIE LIP
Director, KPK Quantity Surveyors (Singapore) Pte Limited

CONTRACTORS

MR EDMUND LEONG
BIM Manager, Tiong Seng Contractors Pte Limited

MS ANG KOOI FUNG
BIM Manager, Woh Hup (Pte) Limited

INTERDISCIPLINARY

MR STEVEN TAN
Senior IT Associate, BIM Specialist, Manager, CPG Corp Pte Limited

GOVERNMENT PROCUREMENT ENTITIES

ER TANG PEI LUEN
Senior Principal Engineer, JTC Corporation

MS CHERLYN LEONG
Principal Engineer, JTC Corporation

MR MARK TUNG
Senior Engineer, Land Transport Authority

INDUSTRY ASSOCIATIONS

ER JOSEPH TOH
Council Member; Director, Beca Carter Hollings & Ferner (SEA) Pte Ltd

MR DOMINIC CHOY
Secretary-General; GM (Projects), Hexacon Construction Pte Limited

MR KUAN CHEE YUNG
Council Member, Singapore Institute of Architects; Senior Vice President (Architecture), CPG Consultants Pte Limited

MR DARREN BENGER
Council Member, Singapore Institute of Architects; Director, ATA Architects Pte Limited

CENTRE FOR CONSTRUCTION IT, BUILDING & CONSTRUCTION AUTHORITY

MR JUSUF ANGGONO
MR CHIDAMBARAM
MR FELIX BATAD
MR SONNY ANDALIS
MS HUANG YIXIANG
MR LIU ZIWEN

1 INTRODUCTION

The ***Singapore BIM Guide Version 2*** aims to outline the various possible **deliverables, processes and personnel / professionals** involved when Building Information Modelling (BIM) is being used in a construction project.

Users can use the Guide to clarify the **roles and responsibilities** of project members when using BIM in a construction project. The roles and responsibilities are then captured in a **BIM Execution Plan,** to be agreed between the Employer and project members.

BIM DELIVERABLES

- This chapter specifies the ***"what"*** to be produced by the respective project member(s) at different stages of a project to meet a set of BIM objectives. All the agreed deliverables are indicated in the **"BIM Objective and Responsibility Matrix"**.

- Each deliverable usually consists of a set of **BIM model elements** (or **elements**). Each element is usually a digital representation of the physical and functional characteristics of an actual building component to be used in the project.

- Each element usually consists of a set of **geometric representations** and **non-geometric attributes**, which can be increased in details as the project progresses.

- This guide also attempts to address the **additional effort** likely to be expended upfront to build up an information-rich BIM model or to perform other BIM value-added services for the project.

BIM PROCESSES (MODELLING AND COLLABORATION PROCEDURES)

- This chapter defines the ***"how"*** and the **steps** taken to **create and share** the BIM deliverables at different stages of the project.

- A set of possible **modelling guidelines** is provided in this Guide to guide the project members in **creating the BIM deliverables** at different stages of the project.

- A set of possible **collaboration procedures** is also provided in this Guide to assist the project members in **sharing the BIM deliverables** with other project members at different stages of the project.

BIM PROFESSIONALS (BIM MANAGER AND BIM COORDINATOR)

- This chapter outlines the ***"who"*** – typical new professionals known as the **BIM manager and BIM coordinator.** They are responsible for the definition, management and completion of the BIM Execution Plan.

The use of BIM can be incorporated into the project as part of the scope of services under the Principal Agreement with the help of the ***BIM Particular Conditions Version 2*****.**

2 BIM EXECUTION PLAN

To effectively introduce BIM into the project delivery process, it is important for the project team to develop a BIM Execution Plan at the early stages of a project. It outlines the overall **vision and along with implementation details** for the project team to follow throughout the project. It is usually defined at the start of the project and when new project members have been appointed, to accommodate their participation.

A BIM Execution Plan helps the Employer and project members to document the agreed BIM deliverables and processes for the project. The Principal Agreement can make reference to the BIM Execution Plan to define the roles and responsibilities of the project members for their BIM deliverables.

By developing a BIM Execution Plan, the Employer and project members can:

- Clearly understand the strategic goals for implementing BIM on the project;
- Understand their roles and responsibilities for Model creation, maintenance and collaboration at different stages of the project;
- Design a suitable process for them to participate in the implementation;
- Outline additional resources and services that may be needed; and
- Provide a baseline plan to measure progress throughout the project

The content of a BIM Execution Plan includes the following:

- Project information;
- BIM goal & uses;
- Each project member's roles, staffing and competency;
- BIM process and strategy;
- BIM exchange protocol and submittal format;
- BIM data requirement;
- Collaboration procedures and method to handle shared Models;
- Quality control; and
- Technology infrastructure & software

The BIM Execution Plan can be appended with additional information to facilitate additional members to join the project at later stages. Updates to the BIM Execution Plan should be made with the permission of the Employer or his appointed BIM Manager and should not go against conditions of the Principal Agreement.

For more information on the BIM Execution Plan, please refer to the ***BIM Essential Guide For BIM Execution Plan***, which also includes a BIM Execution Plan template.

3 BIM DELIVERABLES

This chapter defines "what" – the BIM deliverables" to be produced by the respective project member(s) at different stages of a project to meet a set of BIM objectives. All the agreed deliverables are indicated in the "BIM Objective and Responsibility Matrix".

BIM project deliverables should be agreed upon together with deliverable dates at the start of the project and after the main project members have been appointed so as to accommodate their participations. Some of the typical deliverables are shown below:

- Site model
- Massing model
- Architectural, structural, MEP models
    - For regulatory submissions
    - For coordination and / or clash detection analysis
    - For visualization
    - For cost estimation
- Schedule (material, time etc) and phasing program (in BIM or spreadsheet)
- Construction and fabrication models
- Shopdrawings
- As-built model (in native proprietary or open formats)
- Data for facility management
- Other additional value-added BIM services

3.1 BIM ELEMENTS

Each deliverable usually consists of a set of BIM model elements (or elements). Each element is usually a digital representation of the physical and functional characteristics of an actual building component to be used in the project. A typical set of BIM elements for a project can be found in Appendix A, categorized according to discipline.

3.2 ATTRIBUTES OF BIM ELEMENTS

An important aspect of BIM is the ability to contain information in the model. This information can come in geometric and non-geometric forms.

Table 1: Examples of Geometric and Non-Geometric Attributes of BIM Elements

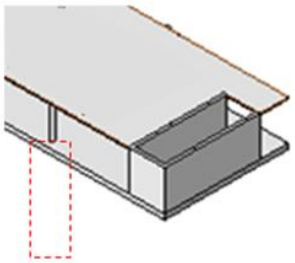
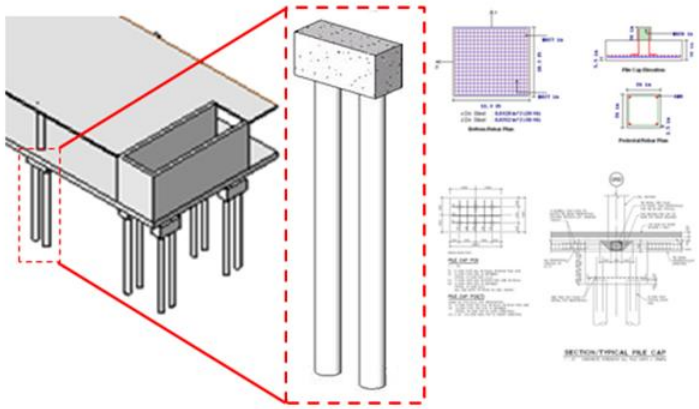
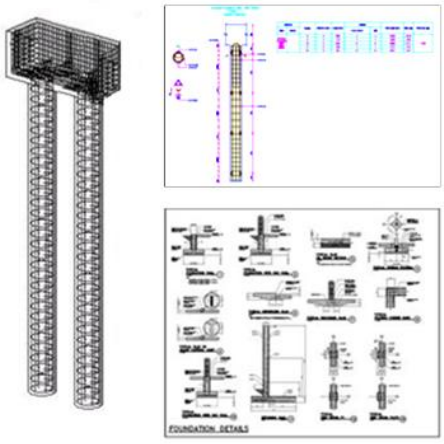
	GEOMETRICAL ATTRIBUTES	NON-GEOMETRICAL ATTRIBUTES
Examples	• Size • Volume • Shape • Height • Orientation	• System data • Performance data • Regulatory compliance • Specifications • Cost

There are a number of national and international efforts attempting to define and standardise the attributes for each BIM element. It is recommended that attributes of a BIM element be determined to meet their intended usage so as to avoid over specifying. References include:

- VA Object/Element Matrix **www.cfm.va.gov/til/bim/BIMGuide/downloads/oemf.xls**
- Level of Development (LOD) Specification **bimforum.org/lod/**

3.2.1 Model Progression

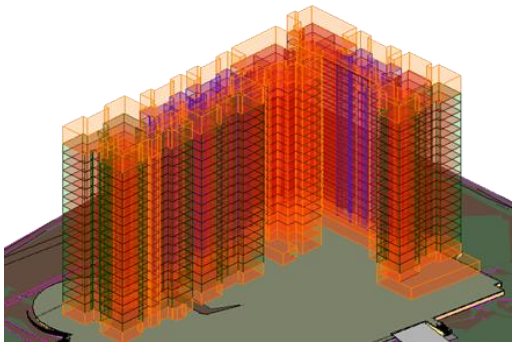
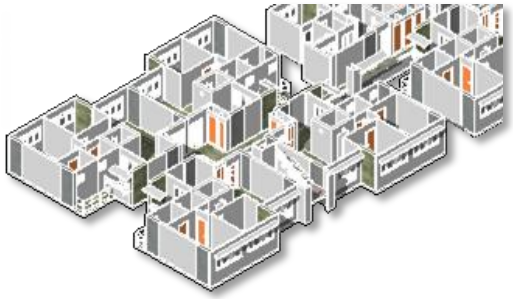
The attributes of a BIM element can change/increase in details as the project progresses. For example, the piling BIM element on the following page shows how its geometric information changes throughout a project, and how this information is represented.

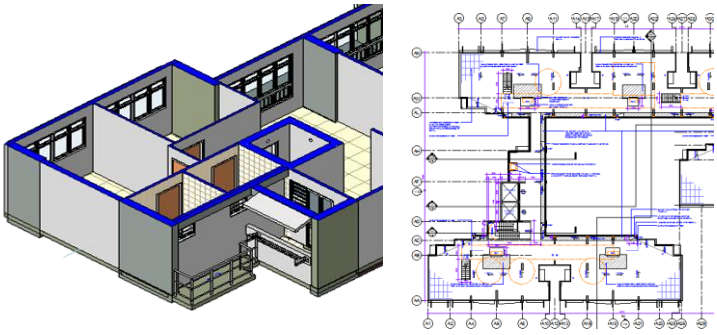
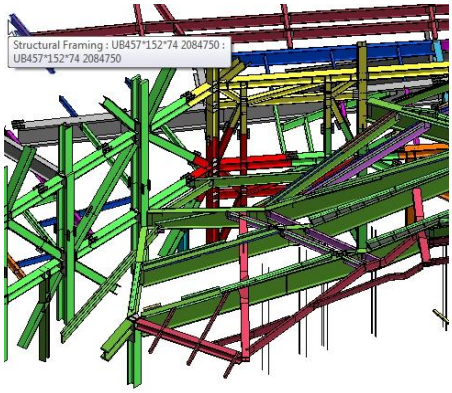
PROJECT STAGES	DETAILS OF BIM
At early design stage, piling may not be modelled due to lack of information	
At the detailed design stage, the piling details have been developed from structural analysis and design. **The pile cap and piles are also accurately modelled and located in the BIM model.** **2D details such as rebars can be used to complement the BIM model**	
During the construction stage, more detailed information is modelled for the piling. Rebars can also be represented in the model in 3D. **It is also acceptable to represent the details in 2D shopdrawings**	

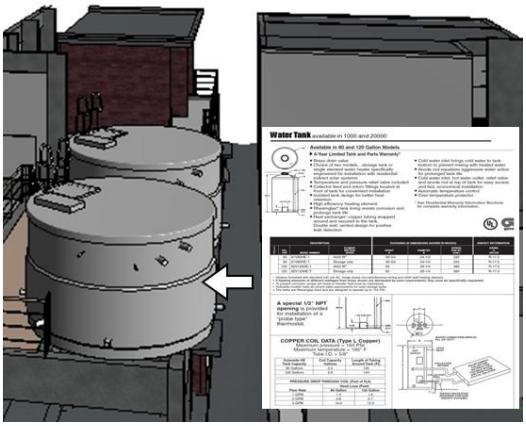
3.2.2 BIM vs 2D Practices

It is essential for local BIM users to relate the BIM deliverables to the current 2D practices. One such example is shown in Table 2.

Table 2: Example of BIM deliverables at different stages

PROJECT STAGES • MILESTONES	2D DRAWING SCALES	GENERAL LEVEL OF DETAIL OF EACH BIM MODEL ELEMENT / ASSEMBLY
Conceptual Design • **Outline Planning Permission** • **Project Feasibility**	1:200 to 1:1000	Building massing studies or other forms of data representation with indicative dimensions, area, volume, location and orientation  **BIM deliverable: massing model (Source: HDB)**
Schematic / Preliminary Design • **Planning Approval** • **Design & Build Tender Documentation**	1:200	Generalized building component or system with approximate dimensions, shape, location, orientation, and quantity. May include non-geometric properties.  **BIM deliverable: preliminary design model (Source: HDB)**

PROJECT STAGES • MILESTONES	2D DRAWING SCALES	GENERAL LEVEL OF DETAIL OF EACH BIM MODEL ELEMENT / ASSEMBLY
Detailed Design • **Building Plan Approval** • **Continued Design & Build Tender Documentation or** • **Design-Bid-Build Tender Documentation**	1:200	More detailed version of a generalized building component or system with accurate dimensions, shape, location, orientation, and quantity. Non-geometric properties should be provided.  **BIM deliverables (from left): detailed design model, BIM-generated detailed drawings (Source: HDB)**
Construction • **Constructability** • **Fabrication**	1:5 – 1:100	BIM element is modelled with complete fabrication and assembly details over and above the Detailed Design stage where applicable or useful for construction works; otherwise, details may be represented in 2D CAD drawings to complement the Detailed Design stage level of detail.  **BIM deliverable: Steel Framing model (Source: Hexacon Construction Pte Ltd)**

PROJECT STAGES • MILESTONES	2D DRAWING SCALES	GENERAL LEVEL OF DETAIL OF EACH BIM MODEL ELEMENT / ASSEMBLY
As-Built • **TOP / CSC** • **Final**	1:100	BIM element is similar in level of detail to the Detailed Design stage, but updated with changes during the Construction stage.  **Comparing the as-built structural model (BIM deliverable, left) with actual site (right) (Source: Hexacon Construction Pte Ltd)**
Facility Management • **O & M**	1:50	BIM element is modelled as an actual constructed building component or system and is an as-built representation of the actual completed building.  **Water storage tank element with attached specification PDF (Source: HDB)**

3.3 BIM OBJECTIVE & RESPONSIBILITY MATRIX

The BIM Objective and Responsibility Matrix indicates the basic BIM deliverables **(1)** required to meet each BIM Project Objective **(2)**. A BIM Project Objective also refers to the use of BIM in a particular stage of the project. It also shows which project members **(3)** are involved in each objective. Columns can be increased or reduced, depending on the number of users (by discipline) involved in the BIM process of the project **(4)**. The last step of defining the matrix is to indicate whether the selected project member is a **model author** or **model user** for each deliverable. **(5)** A matrix template can be found in Appendix B.

2 BIM Project Objective	**3** Project members involved in fulfilling the objective A – model author; U – model users				
	Arch	Struc	MEP	PM	Cont-ractor
Name of building stage: _____ *General description of BIM in this building stage:* _____ *Example:* ***Detailed Design*** *More detailed version of a generalized building component or system with accurate dimensions, shape, location, orientation and quantity. Non-geometric properties should be provided.*					
BIM Project Objective: _____ BIM deliverable(s) to be achieved through this objective: _____ *Example:* 13. Maintain and update the Structural Model, based on the latest Architectural Model • Design, analysis and detailing • In preparation for regulatory submission • In preparation for tender **1** Suggested Deliverable • Structural Model and Calculation	U	A	U	U	FOR REFER-ENCE ONLY

4 **5**

3.3.1 Model Author

The model author is a party responsible for the creation and maintenance of a specific model to the level of detail prescribed in the BIM Project Objectives & Responsibility Matrix. In creating and maintaining the model, the model author does not convey any ownership right of the model. Any subsequent model author's or model user's right to use, modify and transmit the model is specifically limited to the scope of the project. The Employer may specify for ownership of the model in the Principal Agreement. Before providing the model to model users, it is recommended that the model author should perform quality control checks of their models (Refer to Chapter 4.5, page 23)

3.3.2 Model Users

Model users are parties authorised to use the model on the project. The model can be provided in native or neutral (such as IFC) format for the model users' reference and use related to the project. Although model authors have checked the accuracy and quality of the model before sharing with model users, model users should use the model for reference only, and should also check, verify and otherwise confirm the accuracy of the model. Where inconsistency is found in the model, the model user shall promptly notify the model author for clarification. The model users shall make no claim against the author in connection with the use of the model. The model users shall also indemnify and defend the model author against all claims from or related to subsequent use or modification by the model users.

3.4 COMPENSATION EXPECTATIONS

In general, additional upfront preparation is required for one to use BIM effectively and to build up an information rich BIM model as compared with the current use of 2D for design and construction. This upfront work starts with design consultants working on the BIM model at various design stages, as well as with builders who build a construction model from 2D drawing or design BIM model. It is essential to recognise this upfront effort by all the parties.

The Singapore BIM Steering Committee, recognizing that BIM adoption increases efforts at the design stages, recommends a 5% shift in percentage-based consultancy fee payment, from the Construction to Design stages, as illustrated in Table 4. However, this upstream shift of effort does not necessarily result in increased in the consultancy fees.

Table 4: Example of a Payment Schedule in a BIM Project

Project Stage	% change from non-BIM to BIM payment
Preliminary Design	+2.5
Planning Approval	0
Design Development	+2.5
Tender and Award	0
DESIGN STAGES *	**+5**
Construction Administration	-5
Post construction	0
CONSTRUCTION STAGES*	**-5**
Percentage change in total fees	0

* refers to cumulative percentage fees

When releasing design BIM from designers to builders, there may be some cost implications. The Singapore BIM Steering Committee also recommends that this cost should be made known to all builders at the tender stage.

3.5 OTHER ADDITIONAL VALUE-ADDED BIM SERVICES

With BIM, digital analysis may be performed to better understand the performance of the building. These analyses should be considered as additional services. Examples of such services may include the following:

- Environmental simulation and analysis (for Concept Design Purpose only)
- Energy validation to estimate energy usage requirements
- Lighting design validation & visualization
- 4D construction scheduling and sequencing (applicable for Design & Build projects)
- Green Mark, RETV, Buildability and Constructability Scores based on BIM model(s)
- BIM model of existing building(s) for master plan site study and feasibility analysis (A&A)
- Providing Structural and MEP system alternatives based on conceptual massing models
- Project cost estimates based on conceptual massing models
- MEP cost estimates based on MEP BIM model

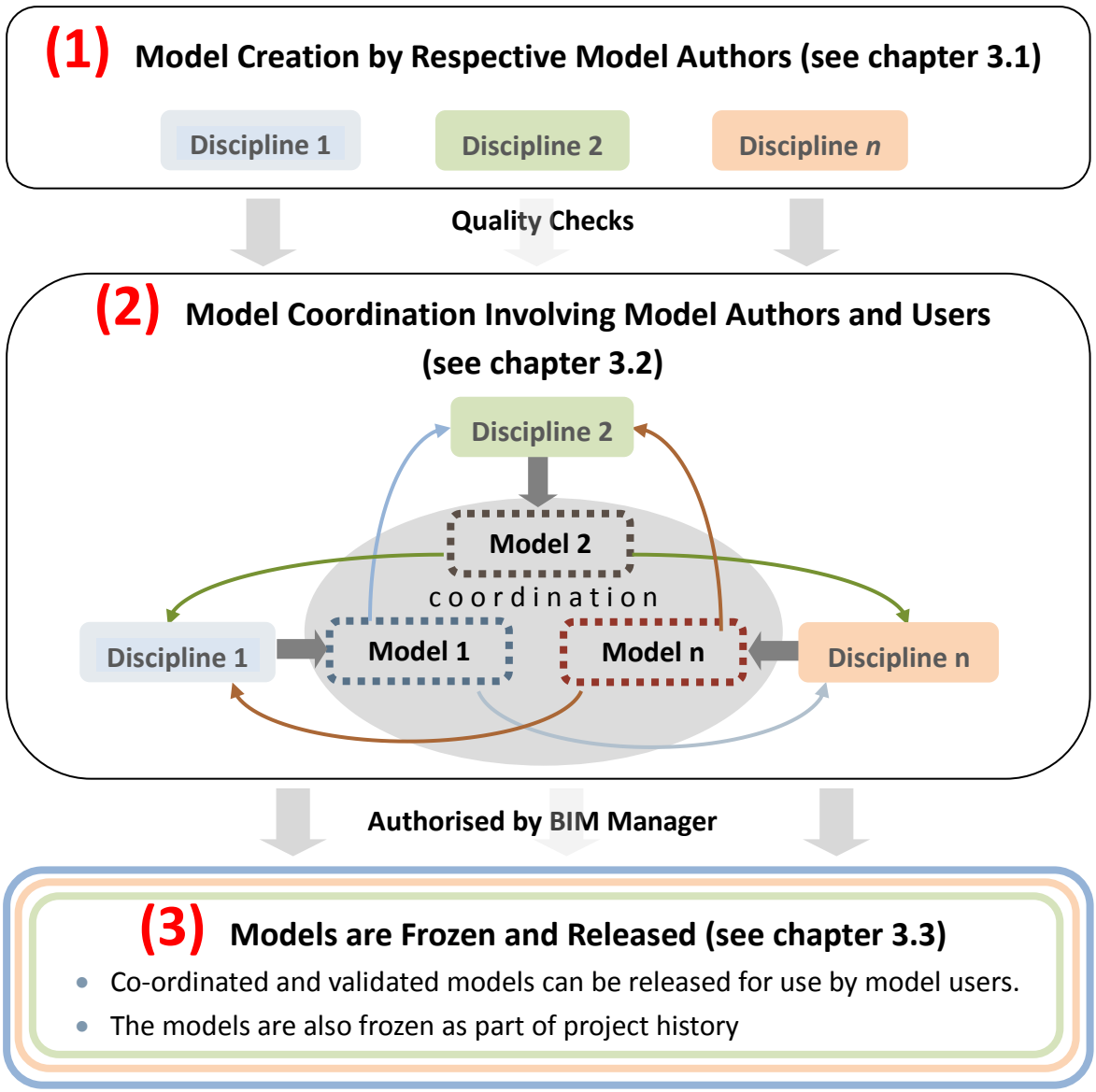
The Employer should understand the potential cost implication for asking such value-added BIM services. It is recommended that additional fees are negotiated among the parties involved.

Furthermore, if BIM services required in the BIM Objective & Responsibility Matrix are agreed to be necessary at an earlier project stage than indicated, these services could also be recognized as additional effort from respective Model Authors. This is because less data is available at an earlier project stage, thus the authors may require additional effort to be able to perform the BIM service.

4. BIM Modelling and Collaboration Procedures

This chapter defines "how" BIM is to be created and shared throughout the project.

A typical BIM process involves model creation **(1)**, model coordination and data exchange **(2)** involving a team of model authors and users. Upon resolution of identified issues (e.g. coordination clashes) during each project milestone, a version of model can then be frozen and released to the model users **(3)**.



4.1 INDIVIDUAL DISCIPLINE MODELLING

At this stage each model author will create his model according to the agreed deliverables as stated in the BIM Execution Plan. The model is stored in and worked on, by the modelling team of each author and has not yet been checked and verified for use outside of the team.

To ensure modelling quality, Model Authors should set up and follow a minimum standard of modelling requirements during BIM project implementation.

4.1.1 Modelling Guidelines for BIM Elements

A set of modelling guidelines for key BIM elements at different stages of a project can be found in Appendix C of this document. The modelling guidelines are grouped by Architectural, Structural and MEP disciplines in this version of the document.

In general, each element will be modelled according to its size, shape, location, orientation and quantity. At the early stages of the project, element properties are more generic and approximate, but become more specific and increases in accuracy as the project progresses.

4.1.2 Modelling Guidelines for Regulatory Submission

Architectural, Structural and MEP modelling guidelines and templates for Singapore BIM e-submissions for regulatory purpose can be found at
http://www.corenet.gov.sg/integrated_submission/bim/bime_submission.htm

4.1.3 Model Orientation

The origin point of the project should be clearly defined and drawn in the SVY21 coordinate system and with reference to the SLA Vertical Control Point (VCP) plus 100m.

4.1.4 Model Division and Structure

Depending on the size of the building and/or the phasing for the project, it may be necessary to divide the model into separate parts, zones and levels. This should be agreed and documented by the modelling team as early as possible.

4.1.5 Revision Management

The model will evolve rapidly during the project stages. Changes should be tracked and documented, especially when the model creation task is divided into a few smaller packages and handled by different people.

There are various software mechanisms to assist BIM authors and users to manage and monitor design changes. BIM authors and users should work with their respective BIM vendor to familiarise themselves with the use of these software mechanisms so that design changes can be managed more effectively. The BIM coordinator for each discipline could play the role of maintaining a register to record the latest information incorporated in the model. They should work closely with the BIM manager to coordinate the version of model shared or exchanged.

4.2 CROSS-DISCIPLINARY MODEL COORDINATION

Project members should share their models with other project members at regular intervals for reference. At certain milestones, models from different disciplines should be coordinated, allowing involved parties to resolve potential conflicts upfront and avoid costly abortive works and delays at the construction stage. Prior to model coordination, the respective models should be checked, approved and validated as “fit for coordination” (see section 4.5 for more information).

It is recommended for the project team to map out a high level coordination flow, as seen in Table 5 on the next page, which shows the interactions between the Employer and project members.

Table 5: Example of a BIM Project Collaboration Map

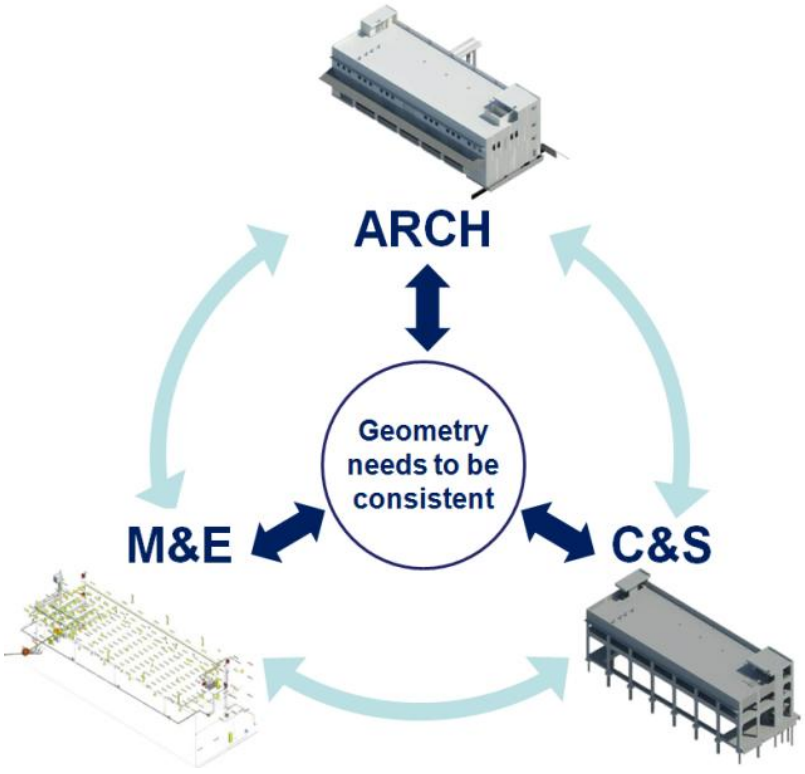
	Employer	Architect	Consulting Engineers	Contractor / Quantity Surveyor
Conceptual Design	Provide requirements related to form, function, cost and schedule	Begin design intent model with massing concepts with site considerations	Provide feedback on initial building performance goals and requirements	Provide feedback on initial building cost, schedule, and constructability ∗
Schematic Design	Provide design review and to further refine design requirements	Refine Design Model with new input from Employer, Consulting Engineers, and Construction Manager	Provide schematic modelling, analysis and system iterations as Design Model continues to develop	Provide design review and continued feedback on cost, schedule and constructability ∗
Detailed Design	Design reviews. Final approval of project design and metrics	Continue to refine Design Model. Introduce consultants models and perform model coordination Finalize Design model, Tender Documents and Specifications, Regulatory Code Compliance	Create Discipline-specific Design Models and Analyses Finalize Discipline specific Design Models, Tender Documents and Specifications, Code Compliance	Create Construction Model for simulation, coordination, estimates, and schedule ∗ Enhance Construction Model and perform final estimate & construction schedule, Manage bid process
Construction	Monitor construction and give input to construction changes and issue	Respond to construction RFI's Perform contract administration, update Design Model with changes	Respond to construction RFI's and update Discipline specific Design Models, field conditions, and commissioning	Manage construction with subcontractors and suppliers, inform changes to Design Model
As-Built		Verify As-built model	Verify As-built model	Prepare As-built model
Facility Management	Engage Architect and Facilities Group for handing over	Coordinate information exchange through model to Facilities Group	Prepare handover documentation	

∗ Applicable to Design & Build projects where the Main Contractor is appointed at the Conceptual Design stage

The project team could leverage on the available software solutions to perform the coordination effectively. A common (software) platform is recommended, to reduce possibilities of data loss or errors when sharing different models. Issues that arose from the coordination should be documented and followed up.

Discrepancies discovered during the coordination process should be recorded, managed, and communicated to relevant model owners through coordination reports, including any specific location of interferences and suggested resolutions.

It is recommended that a revised version of the model should be frozen and signed-off after the issues identified during the coordination exercise have been resolved. A digital signature can be considered to effect the protection.



Source: RSP

4.2.1 Types of Model Coordination

Successful BIM coordination requires careful planning and a clear understanding of different types of coordination process i.e. design coordination, clash detection or space validation.

In early coordination processes, entire models can be run against other models to determine the scope of interference, i.e. objects, elements and selection criteria, for future testing. However, it is important to recognize that not all conflicts detected are problems. Certain conflicts may have been intentional during the modelling process for the sake of simplifying the modelling process. Proper search sets and clash rules should be set up before running the respective coordination processes, to:

- Reduce time and resources spent on detecting false positives.
- Hide elements that are unnecessary in the coordination process, for example, known issues that are to be resolved in later project stages; elements that do not impact the cost when changed on site, etc
- Group particular elements for a specific type of coordination process, such as forming groups between a ceiling search set and an MEP model only during a clash analysis

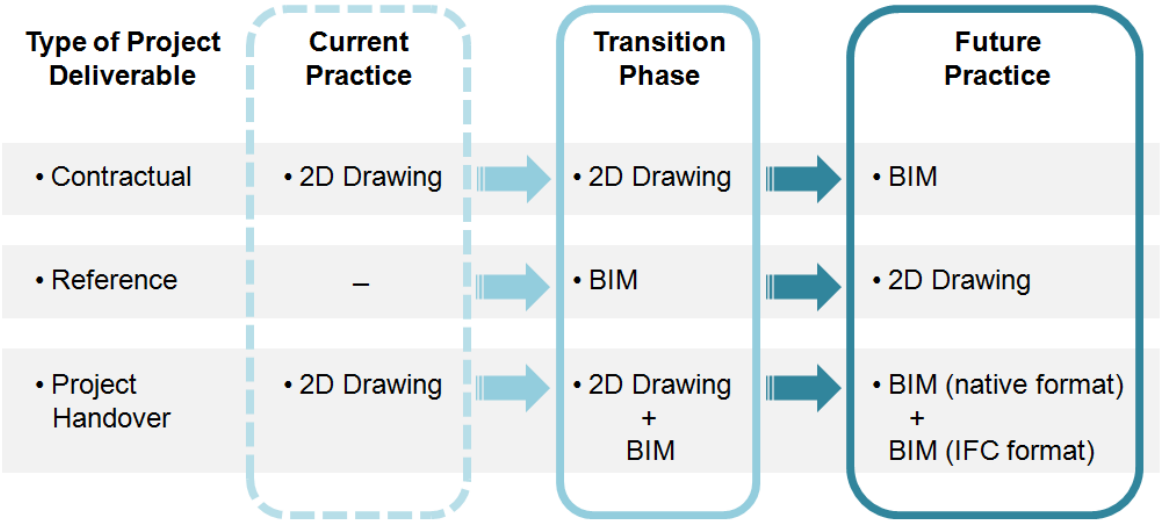
Clash results need to be judged in the context of the elements being analysed, and the type of clash detection software being used. For example, one issue that may occur are duplicate instances of the same clash – for example, a pipe hitting steel could represent 20 clashes when in reality it is only one single issue.

<u>Responsibilities during the coordination process</u>

- Each party owns a discipline-specific model
- During coordination, different models can tap on appropriate software depending on the type of coordination needed
- To resolve clash conflicts, each party carries out agreed changes on their own discipline-specific model
- Liabilities of each discipline-specific model remain the same, before and after the analysis.

4.3 MODEL & DOCUMENTATION PRODUCTION

As of today, the Singapore construction industry is at the "Transition Phase" from the use of 2D drawings to BIM models. In the event of conflict between the contract documents and BIM model, the contract documents shall take precedence over the model.



The changing status of 2D drawings and BIM from current to future practice

4.3.1 Publishing 2D Drawings

Before the industry is ready to accept BIM as part of the contractual documents, there is a need for project members to agree on the standard for 2D drawings that form part of the contract documents. 2D drawings include plans, sections, elevations, details and RFIs, etc.

It is recommended to generate 2D drawings directly from the BIM model, to ensure there are no discrepancies as much as possible. 2D drawings/ details not produced from the BIM models should be clearly labelled.

While the respective disciplines will maintain their own drawing list, drawing numbering and sheet naming systems, the team could determine a common naming convention of views, legends, schedules, sheets and links that could provide a common reference to the corresponding 2D design drawings, tender drawings, working drawings and as-built drawings.

4.3.2 BIM Exchange Formats

Collaboration parties shall also agree on the BIM exchange protocol and submittal format (proprietary or open standard) in the BIM Execution Plan.

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 format could be any of the prevailing open standards, such as the International Foundation Class (IFC) standard, where available. The formats used should be specified in the BIM Execution Plan.

4.3.3 Documentation after Coordination

All output data from BIM models, including published, superseded and 'as-built' data, should be archived in the project folder.

Additionally, at key milestones of the project stages, a complete version of the BIM data and associated deliverables should be copied into an archive location and stored as a record that should not be altered for any reason. It is recommended that the BIM archive consists of two sets of files. The first should be a collection of individual BIM models and associated deliverables as received from the respective Model Authors. The second set of files should consist of the aggregate of those individual BIM models in a format suitable for archiving and viewing.

4.4 DATA SECURITY & SAVING

A data security protocol should be established to prevent any possible data corruption, virus "infections," and data misuse or deliberate damage by project team members, other employees or outside sources. Adequate user access right should be established to prevent data loss or damage during file exchange, maintenance, and archiving. BIM project data residing on network servers should be subjected to regular back-ups.

4.5 QUALITY ASSURANCE AND QUALITY CONTROL

The BIM Manager should establish a quality assurance plan for the BIM models, to ensure appropriate checks on information and data accuracy.

The respective BIM coordinator of each discipline should also establish a quality control procedure to ensure that the discipline model is accurate and correct according to the modelling guidelines.

Each project member should be responsible for performing quality control checks of their design, dataset and model properties before submitting their deliverables.

The following should be considered when determining a quality assurance plan:

- Modelling Guidelines
    - Ensure that the model is created based on the modelling guidelines and CAD standards
- Dataset Validation
    - Ensure that the dataset are populated with correct data.
- Interference Check
    - Detect any clashes between two building components using a Clash Detection software
- Validation of BIM data to be used for Cross-Disciplinary Model Coordination
    - All drawing sheets and extraneous views should be removed from the BIM
    - Each model file should be checked, purged and compressed;
    - File format and naming conventions conform to project Data Exchange protocols.
    - Data segregation conforms to the agreed methods in BIM Execution Plan
    - Model files are up-to-date, containing all users' local modifications
    - Model files are detached from central file
    - Any linked reference files have been removed and any other associated data required to load the model file is made available
    - Model is correctly assembled through visual inspection
    - Any changes since the last issue are communicated to the project team.

More details on Quality Assurance can be found in Appendix C.

4.6 WORKFLOW OF DESIGN-BUILD PROJECTS

The Design-Build project delivery method allows for a single model that is developed to produce the construction documents and fabrication of the building systems.

- Establish a BIM execution plan prior to modelling;
- In schematic design, designers, in collaboration with subcontractors, will create BIM models to meet predefined project requirements.
- Integrate the BIM models into a composite model for coordination and clash detection.
- Interferences will be resolved interactively during coordination meetings;
- Once all conflicts have been resolved, construction documents can be produced
- The Design-Build team will hold installation planning meetings where the coordinated model will be used for review and field installation.
- Allows for accurate digital fabrication of key components off site to be items such as structural steel, precast components, prefabricated units (e.g. facade units).

4.7 WORKFLOW OF DESIGN-BID-BUILD PROJECTS

The traditional Design-Bid-Build project delivery method divides the BIM process into two models - a design model and a construction model. The consultants generate the design model and tender documents. The Main Contractor generates the construction model for construction purposes.

Pre-Tender Stage

- Establish a BIM execution plan prior to modelling;
- Create architectural and system models by design teams;
- Integrate design models for coordination and clash detection;
- Interferences will be resolved interactively during coordination meetings;
- Once all conflicts have been resolved, design and tender documents can be prepared;

Construction Stage

- Models and/or drawings generated from the models will be released to the main contractor for reference only;
- The Main Contractor will develop the model further with construction and fabrication details with fully annotated drawings for/by the sub-contractors

5 BIM Professionals

To facilitate the BIM processes, two new professionals known as BIM Manager for Project, and BIM Coordinators for Consultants and Contractors have been identified in Table 6 below. **These new roles can be undertaken by existing members in the project team**, such as CAD managers, project managers, consultants, contractors, etc.

Besides ensuring that BIM objectives are achieved, the BIM Manager should also ensure that all parties work collaboratively to resolve conflicts in the most efficient way.

The role of the BIM Manager does not include making decisions about design, engineering and construction solutions for the project, nor organizational processes for each discipline.

Table 6: Overview of Responsibilities for New BIM Roles

ROLE	RESPONSIBILITIES IN MODEL MANAGEMENT
Project BIM Manager **(This role can be played by the lead consultant or BIM specialist appointed by the employer or project manager)**	Facilitate the definition and implementation of: • BIM Execution Plan • BIM Goal and Uses • Responsibility Matrix • BIM Deliverables • Delivery Schedules • BIM Modelling Quality Control • BIM Coordination
BIM Coordinator for Consultant	<u>At Design and Construction Stage</u> • Create BIM Design Models and Documentation • Define discipline-specific BIM uses including analysis • Coordinate between BIM modellers, design consultants and cost consultant • Coordinate with contractor and subcontractors • Ensure Modelling Quality Control

ROLE	RESPONSIBILITIES IN MODEL MANAGEMENT
BIM Coordinator for Contractor	At Construction Stage • Coordinate with design consultants and sub-contractors • Study tender documents • Review Design Models and Fabrication Models and Drawings • Use BIM for coordination, sequencing, constructability and cost studies, and field use • Create construction and as built models • Ensure Modelling Quality Control

References

- BCA BIM Submission Guideline for Architectural, Structural and MEP Disciplines
- Finland Sanaatti Properties, BIM Requirements (2007)
- HKIBIM's BIM Project Specification (2011)

Appendix A – Typical BIM Elements by Discipline

Kindly tick and write down the attributes of the selected elements on the table.

(I) ARCHITECTURAL BIM ELEMENTS

	Element	Elements or Parameters needed by each non-Architectural discipline
Site Model	Site infrastructure within site boundary (roads, pavements, car park spaces, access and parking arrangements and surrounding land use)	
	Street fire hydrant (only indication of locations necessary)	
	Surface drainage (only indication of locations necessary)	
	External drainage & underground drainage	
	Hard landscaped areas within site boundary	
	Planter boxes including sub-soil drainage systems	
	Massing of adjacent buildings relevant to project	
Rooms / Spaces	Room spaces, corridors, other spaces, plant and equipment rooms (including designated use)	
Walls and Curtain Walls	Interior / Exterior walls / Non-structural walls / Blockwork walls (*Including finishes to identify if tiled / painted / plastered)*	
	Curtain wall with mullions and transoms with true profile and window glazing units including shading devices	
Doors, Windows and Louvers	Interior / Exterior doors	
	Interior / Exterior windows	
	Louvers	
Basic structure	Beams (based on location and size indicated by the Structural Engineer)	
	Columns (based on location and size indicated by the Structural Engineer)	
Roofs	Roofs with overall thickness (including finishes & insulation)	
Ceilings	Ceilings (without support sub-frames) including module arrangement, material choices and finishes.	
	Hangars and sub-frames for ceilings*	
Floors	Horizontal floors	

	Sloped floors and ramps	
	Floor finishes details including tiling, carpet, screed only	
Vertical Circulation	Steps & stairs including risers, threads and railings including headroom clearance requirements	
	Elevator shafts (without fit-out installations by lift contractor)	
	Access ladders and catwalks	
Architectural Specialties and Casework	Precast / Prefab / GRC / Fibreglass facades	
	Railing & parapets, including mesh & metalwork	
	Fixed Building Maintenance Units in their overall bulk form	
Schedules	Schedules allowing information to be extracted from elements	
Fixtures and Equipment ∗ (with input from interior designers, specialist sub-contractors, etc)	Loose furniture including desks and computer workstations, casework (carpentry), including upper and lower cabinets	
	Appliances such as in kitchen equipment	
	Toilet fixtures, plumbing faucets	

∗ these elements may cause BIM models to become too big and unmanageable.

(II) STRUCTURAL BIM ELEMENTS

Element	Elements or Parameters needed by each non-Structural discipline
Foundations including piles, pile caps, tie / ground beams & footings	
Diaphragm walls & retaining walls	
Beams	
Columns	
Walls	
Slabs, including slab on grade and floating slab, recesses, curbs, pads and major penetrations	
Other types of transfer structure not mentioned above	
Stairs (steps, risers, threads, landings): all framing members and openings	

Shafts and Pits (and openings)	
Precast & Prestressed concrete systems: all primary and secondary elements	
Temporary structures and platforms	
Concrete reinforcement details (Rebar), imbeds and cast-ins ✶	
Steel frame structures including bracing systems ✶	
Base plates, bolts, clip angles, fixings, etc. ✶	
Connection details of structural steel members ✶	

✶ these elements may cause BIM models to become too big and unmanageable.

(III) CIVIL BIM ELEMENTS

	Element	Elements or Parameters needed by each non-Civil discipline
Digital Terrain Model (DTM) ❄	3D surface based on topography that shows site conditions and building locations Include existing walkways, roads, curbs, ramps and parking lots etc	
Geology Report △	Soil investigation report (A BIM Model is not required)	
Utilities Model	All points of connection for existing and new utilities within site boundary	
Rainwater & storm water pipe work	Includes outlets, surface channels, slot channels and manholes	
Underground Public Utilities	For drainage only	
Others	Drains, canals, crossings, retaining walls, and underground harvesting tanks	
	Underground electrical supply cables and sewer lines, IDA (telecom) line and Gas Lines.	

❄ Data of Digital Elevation Model to be provided by registered surveyors

△ Data of Geology Report to be provided by geotechnical engineers

(IV) ACMV BIM ELEMENTS

	Element	Elements or Parameters needed by each non-ACMV discipline
ACMV Equipment	Air Handling unit	
	Chiller unit	
	Variable refrigerant unit	
	Cooling Tower	
	Split-type indoor & outdoor air conditioning units	
	Exhaust or extract air fans	
	Fresh air fans	
	Other fans such as jet fans	
	Heat Exchanges for projects with District Cooling	
ACMV Distribution	Exhaust air ducts (excluding hangars)	
	Fresh air ducts (excluding hangars)	
	Supply air ducts (excluding hangars)	
	Return air ducts (excluding hangars)	
	Transfer air ducts (excluding hangars)	
	Diffusers, air-boots, air grilles, air filters, registers	
	Fire dampers, motorized dampers, volume control dampers, CO_2 sensors, CO sensors	
Mechanical Piping	Chilled water supply pipes including connections, fittings & valves	
	Chilled water return pipes including connections, fittings & valves	
	Condensate drain pipes including connections, fittings & valves	
Others	Switch boards, control, BMS & DDC panels, BMS control & monitoring modules	
	Fan Coil unit	
	Engineering Smoke Extract System (e.g. smoke curtains, ductless fans)	

(V) PLUMBING AND SANITARY BIM ELEMENTS

Element	Elements or Parameters needed by each non-Plumbing and Sanitary discipline
Pipe supports and brackets ∗	
Pumps	
Control panels, monitoring and control sensors	
Plumbing BIM Elements only	
Fresh water piping, fittings, valves including hot & cold water pipe work with all plumbing equipment, sinks	
Water meters	
Storage, water holding tanks	
Pressure Vessels	
Underground Public Utilities for water supply	
Underground Public Utilities for drainage	
Grey water systems	
Pool filtration equipment	
Sanitary BIM Elements only	
Foul drainage, kitchen waste pipe work including floor drains, open trapped gullies, sealed trapped gullies and clean outs, vents and manholes	
Grease and sand traps	
Sump and sewage pits	

∗ these elements may cause BIM models to become too big and unmanageable.

(VI) FIRE PROTECTION BIM ELEMENTS

Element	Elements or Parameters needed by each non-Fire Protection discipline
System piping, droppers, fittings, valves and sprinkler heads, sprinkler inlets, sprinkler control valve set, subsidiary valves, flow switches	
Pipe supports and brackets ∗	
Fire alarm gongs & break glass unit	
Fire sprinkler pumps	
Sprinkler tanks	
Hydrants and hose reels (location of street fire hydrant determined by architects)	
Gas piping for suppression systems	
Heat or smoke detectors, control panels, monitoring and control sensors, pump panels, check meter positions	
Fire extinguishers	
Fire shutters & hoods above	
Smoke Curtains	

∗ these elements may cause BIM models to become too big and unmanageable.

(VII) ELECTRICAL BIM ELEMENTS

Element	Elements or Parameters needed by each non-Electrical discipline
Cable trays, trunking & cable containment, electrical risers, conduit, bus duct, power feeds	
Outlets, panels, wall switches, circuiting to devices, security devices, card access and “plug moulds” (socket points)	
HV & LV switch boards, switchgear, MCCB boards, MCB boards	
Transformers	
Light fittings & fixtures & housings for light fixtures	

Conduit associated with access, data communication, security systems and electrical equipment	
Telecom equipment and computer racks	
Generators and exhaust flues including acoustic treatments	
Diesel tanks & fuel pipes	
Security system including CCTV camera, smart card system, door monitoring system	
Car park control system, barrier gates	
Equipment and associated installations maintained by public utility companies (including manholes / drawpits for the Power Grid)	
Earthing and lightning protection system	
Lifts, PA systems, BMS equipments including display panels (e.g. power consumption display)	

* these elements may cause BIM models to become too big and unmanageable.

(VIII) GAS BIM ELEMENTS

Element	Elements or Parameters needed by each non-Gas discipline
Gas piping and supply	

Appendix B – BIM Objective & Responsibility Matrix (Basic)

Below is an example of a Basic BIM Objective & Responsibility Matrix, from the Conceptual to the FM Stages. The BIM Manager column is optional.

Abbreviations

Project members indicated in the matrix:

- Architect (Arc)
- Civil or Structural Engineer (Str)
- Mechanical, Electrical & Plumbing Engineer (MEP)
- Quantity Surveyor (QS)
- Registered Surveyor (RS)
- Contractor (CON)
- Facility Manager (FM)

Project members involved in the matrix are not limited to the above six professions. Other representatives can be added to the BIM Project Objectives & Responsibility Matrix, such as:

- Project Manager
- Specialist Consultants
- Landscape Designer
- Sub-Contractor
- Specialist Sub-Contractor

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author; U – model users							
		Arc	Str	MEP	QS	Con	RS	FM	Others
Conceptual Design *Building massing studies or other forms of data representation with indicative dimensions, area, volume, location and orientation*									
1. All project members appointed at this stage to agree on needs, objectives, process and outcomes of the project. **Suggested Deliverable** • **BIM Execution Plan agreed and signed by related parties**									
2. Create site BIM models for master plan site study and feasibility analysis. - Site Analysis									

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author; U – model users							
		Arc	Str	MEP	QS	Con	RS	FM	Others
- Apply an Outline Planning Permission if necessary **Suggested Deliverable** • **Site Model**									
3. Create and compare BIM massing models - Space areas and volumes - No. of massing models depend on no. of conceptual design alternatives **Suggested Deliverables** • **BIM Massing Models**									
4. Generate, freeze and store final documentation of the authorized BIM model in the Conceptual Design phase before progression into the Schematic / Preliminary Design stage.									
Schematic / Preliminary Design *Generalized building component or system with approximate dimensions, shape, location, orientation, and quantity. Non-geometric properties may be provided.*									
5. Develop, maintain and update one selected BIM massing model - In preparation for regulatory submission (PP, WP) **Suggested Deliverable** • **Architectural Model**									
6. Develop, maintain and update structural BIM model based on the Architectural Model - Preliminary structural analysis - In preparation for regulatory submission **Suggested Deliverable** • **Structural Model**									
7. Develop, maintain and update MEP BIM model based on the Architectural Model. The MEP Model may consist of Mechanical, Electrical, Plumbing, Water Piping, Fire Protection and Sewerage data. - Preliminary M&E analysis									

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author; U – model users							
		Arc	Str	MEP	QS	Con	RS	FM	Others
- In preparation for regulatory submission **Suggested Deliverable** • **MEP Model**									
8. Implement design coordination between the Architectural and Structural BIM Models. **Suggested Deliverables** • **Preliminary Design Coordination Report (Architectural and Structural Models only)**									
9. Revise project cost estimates based on the Architectural BIM Model **Suggested Deliverable** • **Preliminary Cost Estimate**									
10. Apply for and obtain Planning Approval									
11. Generate, freeze, and store final documentation of the authorized BIM model in the Preliminary Design stage before progression into the Detailed Design stage.									
Detailed Design *More detailed version of a generalized building component or system with accurate dimensions, shape, location, orientation and quantity. Non-geometric properties should be provided.*									
12. Maintain and update the Architectural Model - In preparation for regulatory submission - In preparation for tender **Suggested Deliverable** • **Architectural Model**									
13. Maintain and update the Structural Model, based on the latest Architectural Model - Design, analysis and detailing - In preparation for regulatory submission - In preparation for tender **Suggested Deliverable**									

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author; U – model users							
		Arc	Str	MEP	QS	Con	RS	FM	Others
• **Structural Model and Calculation**									
14. Maintain and update the MEP Model, based on the latest Architectural Model - Design, analysis and detailing - In preparation for regulatory submission - In preparation for tender **Suggested Deliverable** • **MEP Model and Analysis**									
15. Apply for and obtain Building Plan Approval									
16. Develop MEP cost estimates based on MEP model									
17. Implement design coordination between the Architectural, Structural and MEP Models (before issuing for tender) - Identify element conflicts and interferences - Verify valid headroom and working spaces for building operations and maintenance activities - Penetration conflicts will be addressed **Suggested Deliverables** • **Clash Detection and Resolution Report (Architectural, Structural and MEP Models)** • **Spatial Validation Report**									
18. Produce detailed cost estimation and Bill of Quantities (in accordance with the standard method of measurement) based on BIM models. - In preparation for tender **Suggested Deliverables** • **Detailed Quantity Cost Estimate & BOQ**									
19. Generate, freeze and store final documentation of the authorized BIM model in the Detailed Design stage, and update BIM Execution Plan before progression into the Construction stage.									
Construction *BIM element is modelled with complete fabrication and*									

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author; U – model users							
		Arc	Str	MEP	QS	Con	RS	FM	Others
assembly details over and above the Detailed Design stage where applicable or useful for construction works; otherwise, details may be represented in 2D CAD drawings to complement the Detailed Design stage level of detail. *Note: The Contractor shall be solely responsible for claims and liability arising from the use of or access to the BIM Model mentioned in items 20 to 25 below as provided under this stage.*									
20. The contractor will start and continuously update the Detailed Design BIM model to an As-Built BIM Model. The Employer will specify the modelling requirements of the As-Built BIM Model.									
21. Produce Construction Models from Architectural, Structural and MEP Models. The models will be produced in stages. **Suggested Deliverables** • **Construction Models with Key Services Coordinated**									
22. Produce schedules of materials, areas and quantities from the BIM databases for contractors' reference **Suggested Deliverables** • **Schedules of materials, areas and quantities**									
23. Sub-contractors and specialist sub-contractors will generate documents based on the Construction Models **Suggested Deliverables** • **Shopdrawings** • **Fabrication models and drawings** • **Combined Services Drawings (CSD)** • **Single Services Drawings (SSD)**									
24. Where an amendment submission is required from the consultants, the contractors should provide the latest record model and drawings to the consultant whenever requested during the Construction stages. **Suggested Deliverables** • **Record model** • **Record model-generated drawings** • **Other non-BIM deliverables**									

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author; U – model users							
		Arc	Str	MEP	QS	Con	RS	FM	Others
25. Generate, freeze and store final documentation of the authorized BIM model in the Construction stage before progression into the Facility Management stage.									
As-Built *BIM element is similar in level of detail to the Detailed Design stage, but updated with changes during Construction stage.*									
26. The contractor will prepare the final As-Built BIM Model to reflect amendments in the Architectural, Structural, MEP BIM models and the completed form of the construction verified before submitting to the consultants. **Suggested Deliverables** • **Final as-built models for each discipline with the necessary third party certifications**									
27. Consultants to confirm that the As-Built models are in accordance to the BIM model, corresponding to the final approved amendment plans submitted to the relevant Authorities									
Facility Management *BIM element is modelled as an actual constructed building component or system and is an as-built representation of the actual completed building.*									
28. Incorporate as-built information of major systems and equipment in the BIM model elements for provision to the Facility Manager. **Suggested Deliverables** • **Final as-built models fit for space management, building maintenance and modifications made during occupancy by the FM / Employer**									

Appendix C – BIM Modelling Guidelines

The following guidelines recommend how BIM elements should be modelled in different disciplines at different project stages. It does not state who is the Model Author required to model the BIM elements. Modelling guidelines for Facility Management will be addressed in the future version of the Guide.

(i) Overview
(ii) Quality Assurance
(iii) Architectural BIM Modelling Guidelines
(iv) Structural BIM Modelling Guidelines
(v) MEP BIM Modelling Guidelines
    a. ACMV
    b. Plumbing and Sanitary
    c. Fire Protection
    d. Electrical

(I) OVERVIEW

Disciplines / Stages	Architectural Design	Structural Design	MEP Design	Intended Use
Conceptual	Topo, Massing, Site Elements, Site Boundary, Levels, Location, Orientation	*(optional)*	*(optional)*	Site planning, Location of the building(s) on the site, Starting situation for renovation project, Investigation, Visualization, Design options, Investment analysis, Preliminary energy simulation, Alternate spatial designs, Scope management, Investment calculation, Energy simulation, Finalised spatial requirements for structures and MEP systems, Visualisation
Preliminary Design	Building elements with nominal dimensions and details	Load-bearing structures, Proposed structural system & basic structure	MEP Schematics	Definition of building elements, Comparison of building element and structural alternatives, Management of quantity information, Preliminary dimensioning of structures, MEP Analysis, Visualisation
Detailed Design	Building elements with actual dimensions and details	Frame structures, Joints, Foundations, Joining to foundations, Penetrations & Reservations Connections	Service areas of MEP systems, Central units, Ducts, Pipe work, Terminal devices, Switchboards, Cable routes, Lighting fixtures, Penetrations & Reservations	Dimensioning of structures to the precision required for tenders, Definition of MEP systems, Quantity take-off, Penetration & Reservation design, Energy simulation, Visualisation. Combined Services Design
Construction	Model used to extract construction information	Model used to extract construction information	Model used to extract construction information	Detailed Design Information for construction, Prefabricated element design, Production planning
As-Built	Updated detail model as per actual site conditions	Updated detail model as per actual site conditions	Updated detail model as per actual site conditions	Information to be handed over for FM (maintenance & repairs; space & occupancy management)

(II) QUALITY ASSURANCE

Architectural **Detailed Design BIM**	**Structural** **Detailed Design BIM**	**MEP** **Detailed Design BIM**	**Merged model at Preliminary Design, Detailed Design, Construction and As-Built stages**
- BIM in agreed version - BIM includes defined stories - Building elements & spaces modelled separately in each story - BIM includes required building elements - Building elements modelled using correct objects - Building elements include types - No excess building elements - No overlapping or doubled building elements - No significant clashes between objects - No conflicts between structures in architectural and structural BIM - BIM includes GFA spaces objects - Space areas match space program - BIM includes spatial reservations for MEP - Space height defined (including suspended ceilings) - Shape and size of spaces matches with walls - Spaces do not overlap - All spaces have unique IDs	- BIM in agreed version - BIM includes defined stories - Building elements defined separately in each story - BIM includes required building elements - Building elements modelled using correct objects - Building element types are as agreed - No excess building elements - No overlapping or doubled building elements - No significant clashes between objects - No conflicts between structures in architectural and structural BIM - No conflicts between penetrations in architectural and structural BIM - Columns and beams converge - MEP penetrations & reservations included in structures	- BIM in agreed version - BIM includes defined stories - Components defined separately in each story - BIM includes required components - Components modelled using correct objects - Components belong to a correct system - System colours are defined systematically - System colours are defined systematically - No excess components - No overlapping or doubled components - No significant clashes between components - No clashes between MEP disciplines - No clashes between M&E and electrical BIM - Components fit into their spatial reservations - No clashes between M&E, architectural and structural BIM	- All agreed models available - Models represent the same design version - Models are located in the correct coordinate system - No conflicts between vertical shafts and MEP systems - No conflicts between horizontal reservations and MEP - No conflicts between suspended ceilings and MEP - Penetrations of columns OK - Penetrations of beams OK - Penetrations of slabs OK

(III) ARCHITECTURAL BIM MODELLING GUIDELINES

General Architectural Guidelines:

1) Architectural modelling is carried out in the following stages: Conceptual, Preliminary Design, Detailed Design, Construction and As-Built. The types of models produced at each stage depend on the BIM deliverables required.
2) If the design has precast or prefab design then those elements can be placed as Objects.
3) The building elements must be created using the correct tools (Wall tool, Slab tool, etc.). If the features of BIM authoring tool are not sufficient for modelling the element, the required building elements must be created using other appropriate objects. In that case, define the "Type" of the element correctly.
4) 2D can be used to complement the BIM model when the elements are smaller than the agreed size, e.g. Elements smaller than 100mm do not need to be modelled.
5) 2D standard details can be used to complement the BIM model.
6) Building Elements must be modelled separately for each storey.
7) Required Parameters: Type, Material, ID, Size. Type is required for the Quantity Take-off.
8) If more than one tool is used to model certain elements then the elements should be grouped and identified correctly by "Type", e.g. Slabs and Beams can be used to model the Road. The elements must be grouped as one and define the "Type" as a "Road"
9) Structural elements should be modelled based on the information (e.g. Size) from Structural Engineers. The alternative is to link or work in a shared model with the Structural Engineers.

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	Topo (Existing Site)	Existing site's contour and location should be modelled based on the registered surveyor's information (spot levels, northing and easting). Renovation Projects (A&A): If the existing buildings were not in BIM, then 2D drawings of the existing building can be used to complement the BIM model.	Follow BIM e-Submission guidelines for the content and colour code of existing/proposed site. Topographic survey can follow SLA's National Topographic Mapping Standard and Specification (to be released by September 2013)
	Topo (Proposed Site)	Proposed site's cuts and fills of earth should be shown with a proposed site Element	
	Massing (Buildings)	Shape, Location and Orientation of building in site should be modelled using massing element. Name/identify the Mass element clearly, e.g. BLK 1, PODIUM etc. Site elements like Trees, Boundary, Roads, IC, etc can be drawn in 2D.	Output: Concept model that shows site arrangements and building geometries to share with the project members.

Stages	Elements	Modelling Guidelines	Remarks
Preliminary Design Note: Conceptual model is further developed into Preliminary Design model (Massing of the selected design should be converted to real building elements like Wall, Slab, Door, Window, etc...)	General Requirement	If the actual dimension is not available then model using the nominal dimension or expected dimension. Examples - Door opening modelled without considering the fittings. - Walls modelled without considering the different layers thickness. Note: Since the designers has the libraries and templates with element settings, they can model the actual size	Output: Authorities submission (URA). Refer to BCA BIM e-Submission requirement and Guidelines. Use BIM e-Submission Template. Output: Model for co-ordination with Engineers.
	Wall	Model all the Walls (Brick, Dry wall, Glass, Concrete, wood, etc...) from Finish Floor Level to soffit of Slab/Beam above. When the Wall spans across different heights, if the BIM authoring tool permits model as a single Wall with varying height then model as one Wall. Alternative is to model as multiple Walls. Distinguish the internal and external Walls by "Type" parameter.	
	Slab / Floor	Top of Slab = Finished Floor Level When there is a slope in the Slab or the Slab has a special shape and the BIM authoring tool does not have the functionality to create such Slabs, then create the slab geometry using other tools and define the 'Type' as a "slab".	
	Door	Place the Door object with nominal dimensions and parameters required for Preliminary Design.	
	Window	Place the Window object with nominal dimensions and parameters required for Preliminary Design.	
	Column	Model the Columns on the desired locations from Structural Floor Level to Structural Floor Level for the Preliminary Design co-ordination with Structural Engineer. Columns must be modelled by their outer dimensions, taking into consideration the thickness of the finish and structure. Create objects for Columns with special shapes and cross sections.	
	Roof	Model using the Roof or Slab object and define the "Type" as Roof. The supporting structures can be modelled with general objects or beams.	
	Others	If there is a need to model more elements than what	

Stages	Elements	Modelling Guidelines	Remarks
		is specified in the Preliminary Design based on the project, refer to the Detailed Design stage. Model those elements with the information available at this stage.	
	Space group (Zone or Space or Room object)	Note: Similar to individual space/room object Examples - Apartment, Fire Compartment, Departments, GFA Boundary, etc Follow BIM e-Submission guidelines for the details required for the Agencies requirement and display them accordingly in the plans	
	Individual Space (Space or Room object)	Space height = floor height from FFL to the soffit of slab above or the suspended ceiling above. One space may belong to more than one space groups. Area/Volume will be automatically calculated from the space geometry. Follow BIM e-Submission guidelines for the details required by the Agency and display them accordingly in the plans. Give a unique ID that can be used to locate the correct space when there is a need. Name the space based on the function of the room, e.g. Office, Lobby, etc... Follow the BIM e-Submission guidelines for various agencies requirement on the space requirements. Category can be used to group the spaces like Commercial, Residential, etc...	
Detailed Design Note: Preliminary Design model is further developed into Detailed Design model	General Requirement	Model all the elements using the actual/accurate dimension and correct materials.	Output: Authorities submission. Refer to BCA BIM e-Submission requirement and Guidelines. Use BIM e-Submission Template. Output: Model for co-ordination with Engineers. Output: Tender Documents
	Wall	Update the Walls created in the preliminary design with the parameters required for Detailed Design, e.g. Add different Layer thickness, Fire Rating, etc…	
	Load-bearing wall	Load bearing walls includes Core Walls/Shear Walls. Similar to Wall except if the Walls are between Floors then model from Structural Floor Level to Structural Floor Level of Slab below.	
	Slab / Floor	Update the Slabs created in the Preliminary Design with the parameters required for Detailed Design, e.g. Add different Layer thickness, Fire Rating, etc…	
	Door	Update the Doors placed in the Preliminary Design with the parameters required for Detailed Design,	

Stages	Elements	Modelling Guidelines	Remarks
		e.g. Fitting information. It is good to identify the functional difference (Types), e.g. "Fire Door"	
	Window / Louver	Update the Windows placed in the preliminary design with the parameters required for Detailed Design, e.g. Fitting information.	
	Column	Update the Columns created in the Preliminary Design based on the Location and Size information from the Structural Engineer.	
	Beam	Model the Beams based on the Location and Size information from the Structural Engineer. Create objects for Beams with special shapes and cross sections.	
	Staircase / Step / Ramp	Create objects for Staircases, Steps and Ramps with special shapes when it is not available in the BIM authoring tool. If required then the Landings and Stair Platforms can be modelled as Slabs. In that case define their "Type" accordingly.	
	Curtain Wall	Model the Curtain Wall to the full height and not necessary to break it storey by storey. Most BIM Authoring tools enable users to insert Doors and Windows into parts of the Curtain Wall.	
	Balcony	Model using either as an Objects or use Walls, Floors, Beams and Railings. Check the specific elements for their modelling guideline.	
	Canopy		
	Roof	Update the Roofs created in the preliminary design with the parameters required for Detailed Design. E.g. Add different Layer thickness, etc…	
	Skylight	Model using objects and define the "Type" accordingly.	
	Hatch		
	Furniture		
	Balustrade / Railings		
	Project-specific objects		
	Suspended ceiling	If the BIM authoring tool do not have a ceiling tool then modelled using a slab tool or object, and define the "Type" as a Ceiling.	
	Space	Refer to Preliminary Design	
	Civil defence shelter, Service platforms, Structures of	Model using Wall, Floor, Column, Roof, Opening, Objects, Door, Space etc. Check the specific elements for their modelling guideline.	

Stages	Elements	Modelling Guidelines	Remarks
	passageways, Service ducts, Others		
Construction Note: Work together with the contractors and sub contractors to develop the Detailed Design model into Construction model	Refer to Detailed Design model	Model the portions of the buildings that are affected as a result of updates from the Detailed Design models by the other disciplines and variations/RFIs in the design.	Output: Construction model.
As-Built	Refer to Construction model	When the building is complete, the consultant should check the Detailed Design to correspond with the final implementation (As-Built) based on the information from the Contractor.	Output: Model that can be used for space management, building maintenance and modifications made during occupancy by the FM / Employer.

(IV) STRUCTURAL BIM MODELLING GUIDELINES

General Structural Guidelines:

1) The structural consultant produces both an analysis model and a physical model (Structural BIM) with actual member size and position. The model will be used for documentation. These documents cover the Structural BIM only.
2) Structural modelling is carried out in the following stages: Conceptual, Preliminary, Detail, Construction and As-Built. The types of models produced at each stage depend on the BIM deliverables required.
3) If the design has precast or prefab design. The part can be designed and modelled by a specialist and incorporated/linked into the model for reference.
4) Structural BIM covers all load-bearing concrete, wood and steel structures, as well as non-load-bearing concrete structures. The basic building elements used are Wall, Slab, Beam, Column and Lattice. The building elements must be created using the correct tools (Wall tool, Slab tool, etc.). If the features of BIM authoring tool are not sufficient for modelling the element, the required building elements must be created using other appropriate objects. In that case, define the "Type" of the element correctly.
5) The model can be phased and divided for various ST submissions as per the project planning/individual firm's practice.
6) Rebar and Joint details can be done in Detailed Design Stage based on the capability of the BIM authoring tool.

7) 2D or 2D standard details can be used to complement the BIM model when the elements are smaller than the agreed size, e.g. Elements Smaller than 100mm do not need to be modelled.
8) 2D can be used for loading plans.
9) 2D can be used for the column schedule when the BIM authoring tool has limitations. The shape and cutting of each column should be included in the schedule.
10) Building Elements must be modelled separately for each storey
11) Required Parameters: Type, Material, ID, Size. Type is required for the Quantity Take-off.
12) If more than one tool is used to model certain elements then the elements should be grouped and identified correctly by "Type". E.g. Individual beams can be used to model the roof truss the elements must be grouped as one and define the "Type" as a "Truss"

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	Existing Buildings (As-Built Condition) for Addition & Alternations.	The Structural Consultants expertise may required when assessing and modelling existing structures, in particular the load-bearing structural system. The scope of Structural BIM model will be agreed upon on a project-specific basis. If the existing Buildings were not in BIM then 2D drawings of existing building can be used to complement the BIM model.	Output: Structural Model of Existing Building or portions thereof.
	New Buildings	The Structural Consultants expertise may be required in special cases in the assessment of the alternatives massing model from Architect and propose framing systems. Structural BIM model is optional at this stage.	Output: Structural concept alternatives.
Preliminary Design Note: Preliminary Design model will be based on Architectural Conceptual Design model. It will be developed further based on the co-ordination during Preliminary Design stage.	General Requirement	Model the elements using the nominal dimension or expected dimension based on precision available at Preliminary Design stage. Model the elements that are critical and required for Preliminary Design co-ordination (based on projects requirement) Connections/Joints and Members can be detailed in the Detailed Design stage or Construction stage, depending on the project delivery (traditional or D&B).	Input: Geotechnical information/model, Architectural Conceptual Design Model for intended use (for load assumptions) and geometry of the building (to determine the framing system) Note: The location of load bearing elements and the elevation of the floor will be based on the info from the Architect. Output: ST submission. Refer to BCA's BIM e-Submission requirement and Guidelines. Use BIM e-

Stages	Elements	Modelling Guidelines	Remarks
			Submission Template. Output: Model for co-ordination with Architects and MEP Engineers
	Piling (Pile Cap and Pile)	If the BIM authoring tool has relevant objects to represent the foundation elements then place them in the correct level and with the relevant parameter. Alternative is to use Slab, Column and Wall to represent foundation elements. Group them and define the "Type" correctly.	When the design is not confirmed the elements can be modelled as reference to use in the Preliminary Design co-ordination with the Architects and MEP Engineers.
	Diaphragm / Retaining Wall		
	Raft Foundation		
	Pad / Isolated Foundation		
	Strip Foundation		
	Slab / Roof Slab	Top of Slab = Structural Floor Level Multiple Slabs need to be placed if the levels, thickness, span direction and material are different. The soffit of the structural slab should be shown. When there is a slope in the Slab or the Slab with a special shape and the BIM authoring tool does not have the functionality to create such Slabs, then create the slab geometry using other tools and define the 'Type' as a "slab".	
	Beam	Top of Beam = As per design (Up stand Beam or Down hang Beam) Create objects for Beams with special shapes and cross sections, e.g. Tapering and haunch.	
	Truss	Model with multiple elements and group them as a truss. Note: Some BIM authoring tools have a function to automate this process.	
	Column	Model from the Structural Floor level to Structural Floor Level of Slab below. Create objects for Columns with special shapes and cross sections.	
	Wall	All Load bearing Walls and concrete Walls (non-load bearing) need to be modelled, e.g. Core Walls, Shear Walls, Retaining Walls, Diaphragm Walls. If the Walls are between floors then model from Structural Floor Level to Structural Floor Level of Slab below else the Walls need to model to the correct levels. When the Wall spans across different heights, if the	

Stages	Elements	Modelling Guidelines	Remarks
		BIM authoring tool permits model as a single Wall with varying height then model as one Wall. Alternative is to model multiple Walls.	
	Staircase, Step and Ramps	Model only the structure part of the Staircase, Steps and Ramps. Create objects for Staircases, Steps and Ramps with special shapes when it is not available in the BIM authoring tool. If required then the landings and Stair platforms can be modelled as Slabs. In that case define their "Type" accordingly.	
	Opening	Model the structural Opening for the Doors, Windows and Ventilations based on location and size information from the Architects. Model the structural Opening for the MEP elements like Ducts based on the location and size information from the MEP Engineers. Model the Floor openings based on location and Size from the Architects and MEP Engineers.	
	Special Structure Civil defence shelter, Tunnel, Link Way, External structures, Balcony, Canopy, Swimming pool, Temporary structures, Others	Model using Wall, Slab, Column, Beam and Opening or placed as an Object and assign the "Type" accordingly. Check the specific elements for their modelling guideline.	When the design is not confirmed the elements can be modelled as reference to use in the Preliminary Design co-ordination with the Architects and MEP Engineers.
Detailed Design Note: Preliminary Design model is further developed into Detailed Design model	General Requirement	Model all the elements using the actual/accurate dimension. Model all the model elements that are critical and required for the Design co-ordination (based on projects requirement) Detail the Connections/Joints and Members based on the BIM authoring tool's capability. The details can be imported as 2D, which is generated automatically by design tools that can link with BIM authoring tool.	Output: ST Submissions. Refer to BCA's BIM e-Submission requirement and Guidelines. Use BIM e-Submission Template. Output: Tender Drawings. Output: Model for co-ordination with

Stages	Elements	Modelling Guidelines	Remarks
		Divide the project/building as per various ST's or as per agreed Project Plan. Proceed with the modelling according to the schedule.	Architects and MEP Engineers.
	Refer to Preliminary Design	Develop the Preliminary design with more confirmed parameters like Location, Size and Material. Update the correct Type definition that helps detailed quantity take-off.	The detail can be done only for the agreed portion of the building based on the projects need.
Construction Note: Work together with the contractors and sub contractors to develop the Detailed Design model into Construction model	Refer to Detailed Design model	Model the portions of the buildings that are affected as a result of updates from the Detailed Design models by the other disciplines and variations/RFIs in the design. Deepening of structures should be detailed in shopdrawings, if necessary.	Output: Construction model.
As-Built	Refer to Construction model	When the building is complete, the consultant should check the Detailed Design to correspond with the final implementation (As-Built) based on the information from the Contractor.	Output: Model that can be used for operation, building maintenance and modifications made during occupancy by the FM / Employer.

(V) MEP BIM MODELLING GUIDELINES

a. ACMV

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	System distribution lines	Use line diagrams to show the entire system distribution Include equipment symbols in the line diagrams.	Output: Schematic diagrams
	Space objects	Use box objects to represent spaces required for MEP systems Add names and colours to the space objects.	
Preliminary Design	Zone Objects, Air Handling Unit, Chiller Unit Variable refrigerant flow unit,	Zone the spaces that have common design requirements with colour legends on plans. Model each element using the correct BIM generic object	Output: Preliminary Model Shows main distribution

Stages	Elements	Modelling Guidelines	Remarks
	Cooling tower, Exhaust air ducts, Fresh air ducts, Supply air ducts, Return air ducts, Transfer air ducts, Chilled water supply pipes, Chilled water return pipes, Condensate drain pipes	Each element should have an approximate size. Show only the main routes of the systems. All ducts and pipes should be connected to the equipments. Fasteners and hangers are not required. In-line accessories, e.g. valves, fire dampers, volume controls and air filters are not required. Use CP83 symbols.	into different zones Engineers should verify the space allocated by the Architect.
Detailed Design	Main elements of Preliminary Design Fire dampers, Motorized dampers, Volume control dampers Split-type indoor & outdoor air conditioning units Exhaust or extract air fans Fresh air fans Other fans such as jet fans Diffusers, air-boots, air grilles, air filters, registers Fan Coil unit Switch boards, Control, BMS & DDC panels BMS control & monitoring modules	Use CP83 symbols and colour standards Model each element using object correspond to actual component with actual size, material, type code and performance criteria. Include insulation to reflect actual size for coordination purpose. System routing should be connected with fittings. Unavailable BIM objects that are modelled using different objects should be identified accordingly, e.g. use proper names and colours. Downward slopes of the pipes should be modelled realistically. Required fittings allowances, cross-over spaces and maintenance spaces should be considered. Fasteners and hangers are not necessary. Commercial product libraries can be used to the extent allowed by the modelling software. Fire rating should be included in the fire damper objects. Pipe Accessories should follow the CP83 symbols in plan views. For design coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the	Output: Detailed model for e-Submission and Tender For BIM e-Submission, please also refer to submission guidelines Services should be coordinated with architecture model Proposed position of mechanical components base on calculation or analysis e.g. air terminals, FCU should be approved by the architect.

Stages	Elements	Modelling Guidelines	Remarks
		model.	
Construction	The elements are the same as Detailed Design stage.	Model the portions of the building that need more attention. All changes made by contractor & approved by consultants should be clearly indicated. Objects not found in BIM tool can be represented by a box with proper identification and attributes such as equipment name, capacity, etc. Levels of the elements comprising the system from finish floor line or at the certain reference in the model should be clearly annotated. For construction coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model. Fasteners can be modelled if necessary.	Output: Model with construction details Contractor to develop the detailed Design BIM into Construction BIM.
As-Built	The elements are the same as Construction phase.	When the building is complete, the consultant should check the Detailed Design to correspond with the final implementation (As-Built) based on the information from the Contractor.	Output: Model that can be used for space management, building maintenance and modifications made during occupancy by the FM / Employer.

b. Plumbing & Sanitary

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	System distribution lines	Use line diagrams to show the entire system distribution Include equipment symbols in the line diagrams.	Output: Schematic diagram
	Space objects	Use box objects to represent spaces required for MEP systems Add names and colours to the space objects.	
Preliminary Design	Zone objects, Plumbing equipments	Zone the spaces that have common design requirements with colour legends on plans.	Output: Preliminary Model

Stages	Elements	Modelling Guidelines	Remarks
	Plumbing fixtures Sump and sewage pits Storage, water holding tanks, pressure vessels Water meters chambers Manholes, outlets, surface and slot channels	Model each element using the correct BIM generic object Each element should have an approximate size. Show only the main routes of the systems. All main pipes should be connected to the equipments. Fasteners and hangers are not required. In-line accessories e.g. valves, filters, water meters are not required. Use CP83 symbols.	Shows main distribution into different zones Engineers should verify the space allocated by the Architect.
Detailed Design	Main elements of Preliminary Design Fresh water piping, Fittings, Valves, including hot and cold water pipes Rainwater and storm water pipes Foul drainage and kitchen waste pipe work including Floor drains, Open trapped gullies, Sealed trapped gullies, Clean outs, Vents Control panels, Monitoring and control sensors Underground public utilities for water supply Underground public utilities for drainage	Use CP83 symbols and colour standards Model each element using object correspond to actual component with actual size, material, type code and performance criteria. Include insulation to reflect actual size for coordination purpose. System routing should be connected with fittings. Unavailable BIM objects that are modelled using different objects should be identified accordingly, e.g. use proper names and colours. Downward slopes of the pipes should be modelled realistically. Required fittings allowances, cross-over spaces and maintenance spaces should be considered. Fasteners and hangers are not necessary. Commercial product libraries can be used to the extent allowed by the modelling software. Pipe Accessories should follow the CP83 symbols in plan views. For design coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model.	Output: Detailed model for e-Submission and Tender For BIM e-Submission, please also refer to submission guidelines Services should be coordinated with architecture model

Stages	Elements	Modelling Guidelines	Remarks
Construction	The elements are the same as Detailed Design stage.	Model the portions of the building that need more attention. All changes made by contractor & approved by consultants should be clearly indicated. Objects not found in BIM tool can be represented by a box with proper identification and attributes such as equipment name, capacity, etc. Levels of the elements comprising the system from finish floor line or at the certain reference in the model should be clearly annotated. For construction coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model. Fasteners can be modelled if necessary.	Output: Model with construction details Contractor to develop the detailed Design BIM into Construction BIM.
As-Built	The elements are the same as Construction phase.	When the building is complete, the consultant should check the Detailed Design to correspond with the final implementation (As-Built) based on the information from the Contractor.	Output: Model that can be used for space management, building maintenance and modifications made during occupancy by the FM / Employer.

c. Fire Protection

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	System distribution lines	Use line diagrams to show the entire system distribution Include equipment symbols in the line diagrams.	Output: Schematic diagrams
	Space objects	Use box objects to represent spaces required for MEP systems Add names and colours to the space objects.	
Preliminary Design	Zone Objects	Zone the spaces that have common design requirements with colour legends on plans.	Output: Preliminary Model

Stages	Elements	Modelling Guidelines	Remarks
			Shows main distribution into different zones
Detailed Design	Main elements of Preliminary Design Sprinkler pipework Fire sprinkler pumps Sprinkler heads SIB (Sub-Indicator Board) Sprinkler control valve sets (Main stop valve, Subsidiary valve with indicator, Alarm valve, Water motor alarm/gong, Test and drain valve, Pressure gauges and Direct read water flow meter.) Hydrants and hose reels, including street fire hydrant system Fire alarm gongs, Break glass unit Fire shutters and hoods above Gas piping for suppression systems Heat or smoke detectors, Control panels, Monitoring and control sensors, Pump panels, Check meter positions Breeching inlet Breeching inlet cabinet Fire extinguishers	Use CP83 symbols and colour standards Model each element using object correspond to actual component with actual size, material, type code and performance criteria. Include insulation to reflect actual size for coordination purpose. The types, finish, temperature rating and orifice sizes should be indicated. Unavailable BIM objects that are modelled using different objects should be identified accordingly, e.g. use proper names and colours. System routing should be connected with fittings. Required fittings allowances, cross-over spaces and maintenance spaces should be considered. Fasteners and hangers are not necessary. Commercial product libraries can be used to the extent allowed by the modelling software. Pipe Accessories should follow the CP83 symbols in plan views. Size of breeching inlet cabinet For design coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model.	Output: Detailed model for e-Submission and Tender For BIM e-Submission, please also refer to submission guidelines Services should be coordinated with architecture model Engineers should verify the space allocated by the Architect.
Construction	The elements are the same as Detailed Design stage.	Model the portions of the building that need more attention.	Output: Model with

Stages	Elements	Modelling Guidelines	Remarks
		All changes made by contractor & approved by consultants should be clearly indicated. Objects not found in BIM tool can be represented by a box with proper identification and attributes such as equipment name, capacity, etc. Levels of the elements comprising the system from finish floor line or at the certain reference in the model should be clearly annotated. For construction coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model. Fasteners can be modelled if necessary.	construction details Contractor to develop the detailed Design BIM into Construction BIM.
As-Built	The elements are the same as Construction phase.	When the building is complete, the consultant should check the Detailed Design to correspond with the final implementation (As-Built) based on the information from the Contractor.	Output: Model that can be used for space management, building maintenance and modifications made during occupancy by the FM / Employer.

d. Electrical

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	System distribution lines	Use line diagrams to show the entire system distribution Include equipment symbols in the line diagrams.	Output: Schematic diagrams
	Space objects	Use box objects to represent spaces required for MEP systems Add names and colours to the space objects.	
Preliminary	Zone Objects,	Zone the spaces that have common design requirements with colour legends on plans.	Output: Preliminary

Stages	Elements	Modelling Guidelines	Remarks
Design	Transformers HV & LV switch boards, Switchgear, MCCB boards, MCB boards Cable trays, Trunking & cable containment Electrical risers Generators and exhaust flues, including acoustic treatments Diesel tanks & fuel pipes Telecom equipment and computer racks	Model each element using the correct BIM generic object Each element should have an approximate size. Show only the main routes of the systems. All cable trays, conduits and trunkings should be connected to the equipments. Wires, fasteners and hangers are not required. In-line accessories e.g. Valves, fire dampers, volume controls and air filters are not required. Use CP83 symbols.	Model Shows main distribution into different zones
Detailed Design	Main elements of Preliminary Design Light fittings, Fixtures, Housings for light fixtures Conduit, Bus duct, Power feeds Concealed and cast-in-place conduits Outlets, Panels Wall switches, Circuiting to devices, Security devices, Card access, “Plug moulds” (socket points) Conduit associated with access, data communication, security systems and electrical equipment Security system including CCTV camera, smart card	Use CP83 symbols and colour standards Model each element using object correspond to actual component with actual size, material, type code and performance criteria. Include insulation to reflect actual size for coordination purpose. System routing should be connected with fittings. Unavailable BIM objects that modelled using different objects should be identified accordingly, e.g., use proper names and colours. Required fittings allowances, cross-over spaces and maintenance spaces should be considered. Fasteners and hangers are not necessary. Commercial product libraries can be used to the extent allowed by the modelling software. Electrical devices e.g. switches, power outlets, telephone and TV outlets should follow the CP83 symbols in plan views. For design coordination, documents such as coordinated services plans, sections,	Output: Detailed model for e-Submission and Tender For BIM e-Submission, please also refer to submission guidelines Services should be coordinated with architecture model Engineers should verify the space allocated by the architect

Stages	Elements	Modelling Guidelines	Remarks
	system, door monitoring system Car park control system, Barrier gates Equipment and associated installations maintained by public utility companies	elevations, etc. should be derived from the model.	
Construction	The elements are the same as Detailed Design stage.	Model the portions of the building that need more attention. All changes made by contractor & approved by consultants should be clearly indicated. Objects not found in BIM tool can be represented by a box with proper identification and attributes such as equipment name, capacity, etc. Levels of the elements comprising the system from finish floor line or at the certain reference in the model should be clearly annotated. For construction coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model. Fasteners can be modelled if necessary.	Output: Model with construction details Contractor to develop the detailed Design BIM into Construction BIM.
As-Built	The elements are the same as Construction phase.	When the building is complete, the consultant should check the Detailed Design to correspond with the final implementation (As-Built) based on the information from the Contractor.	Output: Model that can be used for space management, building maintenance and modifications made during occupancy by the FM / Employer.



Building and Construction Authority
5 Maxwell Road
#16-00 Tower Block MND Complex
Singapore 059110
www.bca.gov.sg

For more information and feedback on the Singapore BIM Guide, please visit the following blog:
bimsg.wordpress.com