Standard BIM Specification

(Version 0.4)

Construction Industry Council

BLACK: ArchSD BIM specification as the base.
RED: Ron's adjustment including to meet DEVB's TC(W) no. 18/2018 about new mandatory BIM Uses and to cope with new CIC BIM Standards e.g. LOD definitions as well as suggested requirement for the project.
BLUE: supplements reference to the documents from DEVB on 18/1/2018: 3.1 - Consultancy_Brief_Template_for_BIM_v1_9_1.pdf and 2 - Construction_Specification_Template_for_BIM_v1_9_1.pdf
GREEN: additional recommended input as deemed necessary.

Items with brackets [ ] are editable text that the user may edit and reformat before release to project.
Items with "*" means delete as appropriate.

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1. BIM Personnel

1.1 Qualifications of BIM Personnel

Position	Qualification
BIM Manager	1. A valid CIC Certified BIM Manager (CCBM) or satisfy the requirements 2, 3 and 4 below; 2. shall either have corporate membership of an appropriate professional institution or shall have a minimum of five years relevant post-qualification experience plus university degree or equivalent in an appropriate engineering or construction-related discipline; 3. shall have a minimum of three years of practical experience in management of BIM projects; and
Discipline-specific BIM Coordinators : Architectural / Structural/ Building Services	1. a diploma (or equivalent) in Qualifications Framework (QF) Level 4 or above qualification accredited or recognised by a CIC recognised professional body in architecture, engineering, surveying, building or construction, or equivalent as recognised by CIC; 2. Minimum three (3) years full-time relevant work experience; and 3. Minimum one (1) year practical experience in BIM projects.
Discipline-specific BIM Modeller	1. Minimum one (1) year practical experience in BIM projects.

2. Deliverables

2.1 BIM Execution Plan

A BIM Project Execution Plan, the outline of which as per **Appendix 1,** shall be prepared and submitted for the Employer's approval in the design stage. Full details of the BIM implementation and collaboration process shall be defined in the BIM Project Execution Plan. In case of specific information that is not included in this BIM Specification (e.g. model elements or model size limits), such information shall be included in the BIM Project Execution Plan.

The BIM Project Execution Plan shall be maintained as a live document. It shall be reviewed and updated regularly [in quarterly interval] and submitted to the Employer as and when required.

2.2 BIM Models

2.2.1 Contents of Models

The BIM models shall have the property / attribute of system (e.g. Heating, Ventilation and Air-Conditioning system, Fire Protection system) and sub-system (e.g. Supply Air Duct / Return Air Duct / Exhaust Air Duct) such that project team can filter, isolate and manage the model by each complete system or sub-system.

Each type of the model shall include but not limited to the following building objects:

Architectural BIM models

1. Existing site topography, services and buildings; including access to site;
2. Site context of surrounding in massing within the range around the site boundary appropriate for the project.;
3. Generic models for design options;
4. Rooms, spaces, corridors, plant & equipment rooms;
5. Floor slabs, ramps & roofs;
6. Internal and external walls and columns;
7. Doors, shutters and their hoods, access panels;
8. Ironmongery;
9. Curtain wall & precast facades;
10. Windows and louvers;
11. Lift doors;
12. Balustrades, parapets and railings;
13. Staircases;
14. Ramps, raised access floor, false ceilings with access openings;
15. Built-in fixed furniture such as toilet partitions, cabinets;
16. Smoke barriers;
17. Drainage/ Services channel covers;
18. Cat ladders, catwalks, maintenance platforms;
19. Exterior elements such as canopies, sun-shading devices, wall features;
20. Sanitary fitments;
21. Signage;
22. External works such as soft landscape, hard landscape, playground equipment;
23. Headroom;
24. Interior design, furniture, major equipment in different functional areas/rooms;
25. Finishing materials;
26. Prefabricated elements / unit;
27. Modular integrated Construction (MiC)* elements / unit; and
28. Design for Manufacture and Assembly (DfMA)* elements / units.
29. Access / Escape routes with calculations of Travel Distance

Structural BIM models

1. All elements requiring structural, foundation and geotechnical design, including but not limited to foundation, ELS, pile, pile cap, columns, beams, slabs, walls, concrete plinth, structural steel members including bracing systems, connection details for precast elements or volumetric installation;
2. Any precast / prefabricated & prestressed elements/volumetric installation;

3. Details required in congested areas, cast-ins, changes in level and junctions/ connections between structural elements;
4. All penetrations /interfaces between structural members and building services/ E&M services /builder's works. (e.g. openings, curbs, voids, pits, recesses, mass concrete, etc);
5. Reinforcement details for prefabricated, MiC* and DfMA* elements / units and at certain congested zones, to be selected by the Employer or its representatives, for interfacing coordination between reinforcement and building services elements;
6. Specific rendered views, to be selected by the Employer or its representatives, from the BIM model on the structural framework and interfaces to illustrate connections among structural members;
7. MiC* elements / unit; and
8. DfMA* elements / units.

Building Services BIM models

1. Electrical Services;
    a. Transformer (customer owned), switchboard cubicle, cutout panel, motor control centre, motor control panel, uninterruptible power supply unit (> 1 kVA), variable speed drive (standalone), MCCB/MCB board, switch, socket outlet, floor box, fuse spur unit, electric vehicle charging panel/ station, photovoltaic panel, capacitor bank cubicle, harmonic filter cubicle, control /metering panel, luminaire/ light fitting, lamp pole/ bollard, stage lighting bar, occupancy/ daylight sensors, power busduct, cable ladder, cable tray, trunking, generator set, fuel tank, fuel pipe, fuel pump, fuel valve, and relevant system components not embedded into concrete or building structure, circuitry for lighting, etc.
2. Heating, Ventilation and Air-Conditioning Services;
    a. Variable refrigerant volume (VRV) /direct expansion (DX) indoor outdoor units, air-conditioners, primary air-handling unit, fan-coil unit, ventilation/ exhaust fan, water scrubber, air valve, hood, duct, damper, fire /smoke damper, diffuser/ grille, DDC panel, control console, water tank, pipe, valve, flash vessel, chiller, pump, heat exchanger, associated electrical services and relevant system components not embedded into concrete or building structure, etc.
3. Fire Service Installation;
    a. Fire hydrant, hose reel, sprinkler control valve, sprinkler flow switch, sprinkler head, gas flooding discharge head, detector, break glass unit, alarm bell, visual fire alarm, fire alarm panel, battery panel, fire extinguisher, fixed automatically operated appliance, pump, water tank, pipe, valve, exit sign, directional sign, emergency luminaire, associated electrical services and relevant system component not embedded into concrete or building structure, etc.
4. Burglar Alarm and Security System;
    a. Drop arm barrier, mechanical road block, access card reader, door release button, break glass unit, door phone unit, intercom set, CCTV camera, security detector, watchman tour patrol point, central security server rack /console, panel, CCTV video recorder rack, CCTV control console, CCTV/ security system display panel, door control panel,

associated electrical services and relevant system component not embedded into concrete or building structure, etc.

5. Broadcast Reception Installation;
    a. Aerial/ antenna, main equipment panel/ rack, outlet, associated electrical services and relevant system component not embedded into concrete or building structure, etc.
6. Vertical/ Horizontal Transportation System;
    a. Escalator, Lift, vertical platform, landing call panel, lift control panel, lift motor, fireman's switch and associated electrical services, etc.
7. Liquefied Petroleum/Town Gas Installation;
    a. Gas outlet, gas pipe, gas valve, associated electrical services and relevant system component not embedded into concrete or building structure, etc.
8. Plumbing Installation;
    a. Water tank, pump, pneumatic tank, filter, water pipe, valve, fitting, hot water boiler/heater, associated electrical services and relevant system component not embedded into concrete or building structure, etc.
9. Rainwater Harvesting Installation;
    a. Water tank, sand filter, carbon filter, cartridge filter, UV chamber, pump set, pneumatic tank, water pipe, valve, associated electrical services and relevant system component not embedded into concrete or building structure, etc.
10. Drainage/ Sewage Pumping Installation;
    a. Drainage pipe, valve, fitting, manhole, trap gully, drain outlet/ inlet, air vent, sewage pump, associated electrical services and relevant system component not embedded into concrete or building structure, etc.
11. Grey Water/ Sewage Treatment System;
    a. Tank, filter, membrane unit, UV chamber, pump, pneumatic tank, pipe, valve, fitting, associated electrical services and relevant system component not embedded into concrete or building structure, etc.
12. Building Maintenance Unit/Gondola/Hoist
    a. Track, building maintenance unit, gondola cradle, hoist, associated electrical services and relevant system components not embedded into concrete or building structure, etc.
13. Compressed air/gas system
    a. VIE tank, manifold, pipe, valve, alarm panel, air compressed, gas cylinder, associated electrical services and relevant system components not embedded into concrete or building structure, etc.
14. Linen/Refuse Collection System
    a. Linen chute, refuse chute, compactor, control panel, fan, air treatment equipment, food waste composting machine, associated electrical services and relevant system components not embedded into concrete or building structure, etc.
15. Swimming Pool Water Treatment Installation*
    a. Filter tank, pump, control panel, pipe, valve, water tank, associated electrical services and relevant system components not embedded into concrete or building structure, etc.
16. Catering Equipment Installation*
    a. Cooking range, oven, sink, tap, bench, shelves, cabinet, cold room, exhaust hood, air treatment equipment, control panel, pipe, valve, grease

trap, associated electrical services and relevant system components not embedded into concrete or building structure, etc.

17. Pneumatic Tube Transport System*
    a. Sending and receiving station, tube, diverter, blower, associated electrical services and relevant system components not embedded into concrete or building structure, etc.
18. Steam Boiler*
    a. Boiler, chimney, fuel tank, pipe, pump, valve, steam trap, water tank, chemical dosing equipment, associated electrical services and relevant system components not embedded into concrete or building structure, etc.
19. Installation Accessories;
    a. Hanger, installation fixture, hoisting beam, chain block, hoisting eye, etc.
20. Intelligent, sustainable, green and smart building systems;
21. Information Technology Equipment and Accessories;
    a. Server, Router, connection point, etc.
22. Conduits;
    a. Conduits with all sizes shall be modelled for all prefabricated units, MiC* units and DfMA* units and other areas of the project in general.
23. Building services in MiC* elements / unit; and
24. Building services in DfMA* elements / units.

Site BIM models

1. Temporary works e.g. falsework, scaffolding, site hoarding, fencing, elements for site layout planning and management, access to site;
2. Elements for safety measurement, management, control and training; and
3. Construction conveyors / transportation tools e.g. tower cranes, mobile cranes, construction vehicles.

Underground Utilities BIM models

1. Gravity flow network / system such as sewer, storm drainage;
2. Pressure network / system such as water, gas, cooling main, oil/fuel pipe;
3. Electricity network / system such as power and lighting;
4. Telecom network / system such as telecom cables and fiber optics; and
5. Other network / system such as SCADA, common utility tunnel.

2.2.2 Level of Development (LOD)

The LOD to be adopted for the BIM models are in terms of both geometry/graphical presentation and building information. LOD notations are comprised of numbers from LOD 100 to LOD 400 and are defined as follows:

LOD 100	The Model Element is graphically represented within the Model with a symbol or generic representation. Information related to the Model Element (e.g. cost per square foot, tonnage of HVAC, etc.) can be derived from other Model Elements.
LOD 200	The Model Element is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, assumed size, shape, location, and orientation. The assumed required spaces for access and maintenance shall be indicated.

LOD 300 The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. The model / object shall include details for the indication of required spaces for access and maintenance for handling installation, operation and maintenance needs and the details for interfacing checking and coordination with other models / objects. The graphical representation can be recognised easily without further clarification.

LOD 400 The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing for fabrication, assembly and installation.

The LOD to be adopted in the project are required as follows:

1. Geometry/Graphical presentation
   a. In design stage, BIM databases / objects shall be modelled at up to LOD300 in general subject to the availability of design information and the instruction from the Employer. LOD200 may be accepted by the Employer for particular objects with reasonable supporting reasons.
   b. In construction stage, BIM models / objects shall be modelled at LOD300 in general. While for prefabricated, MiC* and DfMA* units / elements shall be modelled at LOD400. For AM and facilities upkeep purpose, the models / objects shall be field verified representing in terms of size, shape, location, quantity, and orientation.
   c. BIM databases to be built shall meet and satisfy the needs of the mandatory BIM Uses as specified in the Table of BIM Uses of this BIM Specification fit for purposes. Sufficient LOD shall be applied.
2. Building Information
   a. Building information, attributes and parameters shall be embedded or linked to the BIM models and database to enable AM and facilities upkeep. The Contents shall be instructed and agreed by the Employer.

The LOD of BIM elements for each discipline-specific model shall be defined clearly for each stage and shall be listed in the LOD responsibility Matrix as part of the BIM Project Execution Plan.

2.2.3 File Size of Models

For efficient handling of models, the models should be sub-divided into separate zones / services / systems as appropriate to maintain reasonable file size of the models. The model sub-division strategy (by zones / services / systems) shall be stated in the BIM Project Execution Plan. File sizes of each sub-divided BIM model shall be kept in minimum by purging of unused views, BIM objects and settings before publish or submission. The maximum file size for each sub-divided BIM model should not exceed 400MB unless otherwise approved by the Employer.

2.2.4 Model Federation

Model federation shall be well-defined in the BIM Project Execution Plan and used as a discussion media during the regularly scheduled BIM Progress / Coordination

Meetings. Federated information for both file management and collaboration activity shall be provided. The federated information shall contain a federated model (a single model that combines all individual discipline / discipline specific BIM model in the project area) that allows for the project participants, including Employer's staff, to go through the design review, clash analysis and coordination process.

2.3 BIM Objects

All BIM objects created shall comply with the latest version of the CIC's Production of BIM Object Guide – General Requirements. A complete library of all BIM objects of the project shall be submitted upon the design stage and construction stage respectively for the approval by the Employer.

2.4 BIM Uses

2.4.1 Design Authoring

Design authoring is the process of using BIM authoring software and tools to create and develop a Building Information Model of the project which includes a database of properties, quantities, means and methods, costs and schedules. The architect, engineer, consultant, contractor and sub-contractor shall use the BIM authoring software and tools to develop their designs and produce views and drawings including but not limited to 3D perspective, layout plan, elevation, section, detail, fabrication and shop drawings. The software and tools are also used to produce schedules (room, door, window, finishes, and panel for distribution board, etc.), which applies to all disciplines.

2.4.2 Design Reviews

Design review is a process for stakeholders to view a model, images from the models or animated walk-throughs of the project, provide feedback and validate numerous design aspects such as meeting the Employer's requirements and previewing spaces and layouts in digital deliverables. The reviewers can check layout, sightlines, lighting, security, disabled access and egress, way finding, ergonomics, acoustics, textures and colours, etc. The review can be done by using computer software only or with special virtual mock-up facilities, such as immersive lab, etc. Virtual mock-ups can be performed at various levels of detail depending on project needs.

BIM authoring software and tools with functions such as real-time high definition rendering, user interactions and simulations can be used to facilitate the effectiveness and efficiency of the design review / presentation process and meetings. Fully rendered still shots, animated BIM renditions, fly through and walk through visualisation can be produced for design review to facilitate the coordination meeting and public engagement.

2.4.3 Existing Conditions Modelling

Existing conditions modelling is the process of creating a 3D model of the existing site conditions. The model may be developed from laser scanning, photogrammetry, conventional survey methods and record drawings. For historic graded buildings, the author may include a heritage documentation and assessment. The existing condition models are used for design visualization and planning as well as field verification.

In the design stage, 3D digital survey technology such as laser scanning can be used to provide both point cloud and mesh model of the existing site condition. In the construction stage, 3D digital survey technology such as laser scanning to provide as-built condition verified for the construction works. It provides documentation of environment for future modelling and design coordination.

The 3D digital survey model shall be supplemented by photographic records of condition survey.

The 3D digital survey model shall be georeferenced to the same absolute coordinate system, e.g. Hong Kong 1980 Grid, according to x, y, z coordinates and comply with the Lands Department's standards and guidelines. The format can be:

1. Point Cloud (.las)
2. Build mesh (.tin)
3. Export ortho-image (.jpeg, .png and .tiff)
4. Video (H.264 & other formats specified in the latest version of OGCIO – The HKSARG Interoperability Framework (S 18))

2.4.4 Site Analysis

Site analysis is the process to make use of BIM and Geographic Information System (GIS) tools to evaluate the site to determine the most optimal location, position and orientation for the project. The analysis shall include master planning, visual analysis / sight of line analysis, site context analysis, sun and shadow studies, daylight analysis and solar envelope analysis.

2.4.5 BIM/3D Coordination

BIM/3D Coordination is the process of using Clash Detection software and tools to identify conflicts by analysing BIM models of the different building systems and elements. The goal of the coordination process is to eliminate clashes before construction of the project. The BIM coordination process shall include checks for spatial and headroom requirements, working spaces for building operations and maintenance activities, installation and replacement of equipment and machines, etc.

The procedure of clash detection are:

1. to compare BIM models built up from design of different disciplines and BIM models and/or shop drawings from sub-contractors
2. to identify clashes;
3. to report to the Employer or its representatives;
4. to revise design information and shop drawing;
5. to rebuild / update BIM models; and
6. to perform another round of analysis until clashes are eliminated.

Any conflicts, clashes and coordination issues identified shall be documented in the format of clash report to categorise, prioritise and compare the different clashes, record the clash detection process and assumptions on element tolerances, areas and elements, identify any major conflict discovered in the process and generate resolution result summary. Clash reports shall be part of the BIM progress report, which shall address but not limited to the following:

1. clash detection software and version;
2. revision / version of the discipline BIM models;

3. process overview;
4. responsibilities;
5. outputs;
6. technical query workflow;
7. summary of the clash records shall derived from all clash reports. This summary shall show whether the clashes are gradually increased or deducted;
8. clash resolution process;
9. clash identifications and resolutions;
10. action plan with target completion schedule to handle and resolve detected clashes;
11. tolerance levels (mm) for different disciplines;
12. 3D close-ups of the BIM models;
13. location maps;
14. references to drawings (if available);
15. headroom clearance;
16. operation clearance;
17. maintenance clearance;
18. buildability; and
19. services compatibility.

2.4.6 Cost Estimation/ 5D Modelling

Cost Estimation /5D modelling is the process which BIM can be used to assist in the generation of accurate quantity take-offs and cost estimates throughout the lifecycle of a project. In general, the BIM shall be devised to enable easy and accurate quantity take-off (QTO) by extracting quantities from the BIM models in which the quantities extracted can comply with the requirements in the Hong Kong Standard Method of Measurement of Building Works Fourth Edition (HKSMM4) published by the Hong Kong Institute of Surveyors and the project specific by the Employer, if any, as far as possible and used by the QS Consultant to develop cost estimates and carry out cost related tasks in a 5D BIM software / platform for the project.

In design stage, the BIM models shall enable the QS Consultant to use the quantities extracted from the BIM models for project cost budgeting, project cost control and cost evaluation on design options, etc. as far as practicable.

In tendering stage, the BIM models shall enable the QS Consultant to prepare the Bills of Quantities [and the BIM models shall form part of tender information to indicate the design intent layout and the material quantities for the tenderers' information].

In construction stage, the BIM models shall enable the QS Consultant to use the quantities extracted from the BIM models for project cost control, cost evaluation on variation of works, cash flow forecast, spending analysis, interim payment, etc. as far as practicable. The 5D Model shall be adopted in the regular project progress meeting to indicate and compare the current cash flow status with the baseline forecast to facilitate project management.

2.4.7 Engineering Analysis

Engineering analysis is a process which uses the BIM model to analyse and assess different design options to determine the most effective engineering solution to meet design codes and client requirements.

For structural analysis, the analytical modelling software uses the model to determine the behaviour of a given structural system.

For lighting, energy, thermal, mechanical, acoustic, people movement analysis, the model can be used to predict the performance of a system which can then be compared to actual performance data such as commissioning results.

For civil engineering projects, the models could be analysed for hydraulic design of water supply, sewerage and storm water drainage systems.

2.4.8 Facility Energy Analysis

Facility energy analysis is a process of using a building energy simulation programme with a model to conduct energy assessments of a project design to optimize the design to reduce life-cycle costs.

2.4.9 Sustainability Evaluation

Sustainability evaluation is a process in which a project model is evaluated based on HKBEAM, LEED or other sustainable criteria.

2.4.10 Space Programming

Space programming is the process of using BIM for checking Employer's spatial requirements such as compliance with the approved schedule of accommodations, reference plot ratio for the project and site coverage of greenery for the project, and other spatial requirements relevant to the project as considered appropriate.

2.4.11 Phase Planning (4D Modelling)

Phase Planning (4D Modelling) is a process in which a 4D model (3D models with the added dimension of time) is utilized to effectively plan the construction sequence and space requirements on a building site.

In the design stage, Phase Planning (4D Modelling) shall include construction sequence simulation for visually demonstrating and communicating project construction sequence based on proposed design and requirements on the project. Construction activities with very high to extreme risk level identified from the Systematic Risk Management (SRM) according to ETWB TC(W) No. 6/2005 shall be included. The BIM shall include all major systems and shall contain sufficient data to show planned sequential construction in animation. Any assumptions (e.g. construction programme, phasing, temporary structures, if any) shall be communicated, commented and agreed by the Employer. The 4D simulations should also include the demonstration of the sequence of construction of the prefabricated, MiC* and DfMA* elements / units from fabrication, transportation to installation on site. The swept path analysis from the port (marine transport) or factory (land transport) to the site of the above elements / units is also required.

In the construction stage, 4D Model simulations to the construction process of the construction works shall be provided to:

1. establish relationships between the programme and sequence of construction activities including the delivery of material, equipment to be carried out during the construction, operation routes and installation sequence of the major machinery & plants, site logistics, typical construction cycle, site operation, etc.;
2. demonstrate the sequences od works and site access;
3. identify potential time and spatial conflicts;
4. optimize the use of critical resources;
5. enhance safety requirements, construction process control and consider to use BIM for training to achieve Site Safety Supervision Plan (SSSP);
6. minimize disturbance to the operation of the neighbourhood;
7. better co-ordinate with affected parties and resolve interfacing issues at early stages; and
8. monitor procurement status of project materials.

In the construction stage, a 4D programme for construction progress monitoring shall be demonstrated in daily intervals, linking all activities in the master programme and it shall be automatically matched with the activities as shown in the master programme with appropriate file format. The 4D programme shall evolve with project progression. Time and other 4D-related information within WIP BIM shall be concurrent with the outputs. The 4D programme shall be used in the regular project progress meeting to indicate and compare the current actual construction progress with the baseline programme to facilitate project management.

The deliverables of Phase Planning (4D Modelling) shall contain the following but not limited to:

1. description of the Phase Planning (4D Modelling), including the assumptions, time interval, construction method statement, guide for accessing the files and BIM models...etc.;
2. videos of the 4D simulations:
   The 4D walkthrough / flythrough simulation/animation videos from the BIM shall be no longer than 2 minutes each, 30 frames per second, 1080P resolution. The videos of the 4D simulations shall be submitted in required file format viewable in standalone free viewer;
3. native and editable BIM models;
4. models for the Phase Planning (4D Modelling); and
5. linked project programme or spreadsheet or equivalent deliverable.

The deliverables of Phase Planning (4D Modelling) shall enable the further development of the deliverables as specified in the Clause of Cost Estimation / Financial Model (5D Model) of this BIM Specification.

2.4.12 Digital Fabrication

Digital Fabrication is the process for digitalizing the construction details in the BIM model for mass customised components such as metal cladding, acoustic panels, building façade panels, ceiling panels, acoustic barriers, metal structural members, etc. which are of large quantities and variety in dimensions, shapes, geometries, etc. Digital Fabrication shall be adopted for prefabricated, MiC* and DfMA* units / elements.

As far as practicable, the BIM models shall be able to transfer directly to the Computer Numeric Control (CNC) machines for fabrication and manufacturing. The BIM models can also be used for prototyping with 3D printers as part of a design intent review process.

2.4.13 Site Utilization Planning

Site utilisation planning is the process of using models to graphically represent both permanent and temporary facilities on site for all of the phases of the construction process. The models may be linked to the construction schedule (4D) to review space planning, site logistics, sequencing requirements, temporary works and safety.

Site utilisation planning shall be adopted in construction stage for the construction activities with very high to extreme risk level identified from the SRM according to ETWB TC(W) No. 6/2005 or other activities as considered appropriate at construction stage.

2.4.14 3D Control and Planning

3D Control and Planning is a process that utilizes a model to layout project elements such as the position of walls using a total station with survey points preassigned in the model. The process of automating the control of equipment's movement and location such as using GPS coordinates to determine if proper excavation depth is reached.

2.4.15 As-Built Modelling for AM and Facilities Upkeep

As Built Modelling for AM and Facilities Upkeep is the process used to depict an accurate representation of the physical conditions, environment, and assets of a facility, which shall be adopted in construction stage. As-built BIM model of all components shall be submitted as described in Clause of Deliverable 'BIM Models' of this BIM Specification.

The as-built BIM model shall be based on the final approved construction information that had actually been built, and shall be used to produce as-built drawings. Information on location such as room number, room name and building name, staircase number, washroom number, lift lobby number is required to be incorporated into the as-built BIM model. The operation data, product catalogues, manuals, warranties and maintenance history of equipment, etc. shall also be imported and displayed into the as-built model.

The as-built BIM models shall be prepared in accordance with the guidelines as detailed in **Appendix 2.** As-built construction and equipment components of the project with information as listed below shall be included for future handover to the Employer:

1. Room Data Sheets;
2. Door Schedules;
3. Ironmongery Schedules;
4. Window Schedules;
5. Access Panel Schedules;
6. Shutter Schedules;
7. Cat ladder Schedules;
8. Louvre Schedules;
9. Sanitary Fitment Schedules;

10. Signage Schedules;
11. Roofing System;
12. Comprehensive materials data sheet list and completed materials/equipment warranty list;
13. Other textual information subject to agreement of AM and FM at later stage;
14. 360-degree spherical panoramic photographic record showing the on-site as-built condition and 3D digital point cloud from field verification such as laser scanning to the whole development in accordance with the Employer's BIM Guide for Facilities Upkeep;
15. As-built BIM models and 2D drawing files for building services installation;
16. Export data files, if any;
17. Folder storing the building services object files;
18. Testing and Commissioning reports;
19. Operation and Maintenance manuals;
20. Relevant statutory certificates, approval documents and forms; and
21. Other relevant project information as required.

The as-built model shall be provided with animation for assemble sequence of works for the typical floor construction including both in-situ, precast, semi-precast, MiC*, DfMA* and prefabricated units sequence of works for viewing in standalone free viewers. The objective of the animation is to illustrate how to maintain the special part of the building. In general, the animation shall not be lower than LOD300 with LOD400 particularly for the MiC* units, DfMA* units and prefabricated units. The extent of the animation required will depend on the design of the building.

The required as-built data and relevant documentations shall be stored under a standardized file folder structure.

[The As-Built model shall include a sharable BIM model base on the instruction and requirements by the Employer at the time. The sharable BIM model aims to be input into a platform which is interfaced with Common Spatial Data Infrastructure (CSDI) for Digital Hong Kong. The platform will be provided by the Employer or HKSARG.*]

2.4.16 Project Systems Analysis

Project systems analysis is the process measures how a project performs compared to the design specifications. This may include assessing how a mechanical system operates, how much energy a project uses, conducting lighting analysis, solar gain analysis and airflow analysis using CFD.

2.4.17 Maintenance Scheduling

Maintenance Scheduling is the process in which the functionality of the building structure (walls, floors, roof, etc) and equipment serving the building (mechanical, electrical, plumbing, etc) are maintained over the operational life of a facility. It shall be adopted in construction stage in providing maintenance attributes for facility structures, fabrics and equipment in the as-built models as considered appropriate. A successful maintenance program will improve building performance, reduce repairs, and reduce overall maintenance costs.

2.4.18 Space Management and Tracking

The As-Built model can be used to assess, manage and track spaces and associated resources within a project. A BIM database may be integrated with spatial tracking software to analyse the existing use of space, apply transition planning for renovations and refurbishment projects.

2.4.19 Asset Management

Asset management is the process of bi-directionally linking an As-Built Model database to an organised building management system which can be used to maintain and operate a facility and its assets. The assets may include buildings, infrastructure, systems and equipment which may be operated, maintained and upgraded. The process utilizes the data contained in an As-Built Model to populate an asset management system. The bi-directional link allows users to visualize an asset in the model before servicing it. The facility manager shall specify the data required for each element in the BIM PXP.

2.4.20 Drawing Generation (Drawing Production)

Drawing generation is the process of using BIM to produce 2D drawings, which shall be adopted in both design stage and construction stage. In design stage, BIM shall be used for design development with statutory plan development and submission to the approving authorities of the HKSARG including Buildings Department (BD), etc. The types of statutory plan shall include but not limited to the following items:

1. General Building Plan
2. Superstructure Plan
3. Foundation Plan
4. Excavation and Lateral Support (E&LS) Plan
5. Site Formation Plan
6. Ground Investigation Plan
7. Demolition Plan (included Hoarding)
8. Drainage Plan

The following items shall also be determined with the aid of BIM:

1. Fundamental checking equivalent to the Standards as per current practice notes;
2. Checking of gross floor area;
3. Checking of means of escape;
4. Checking of sanitary fitment provision; and
5. Checking of fire compartment and fire resisting construction.

At the end of design stage, the final design BIM models and related deliverables as record documents shall be provided. The final design BIM models shall be design-error free BIM models without any design conflict. The final design BIM models shall be delivered in their native and editable format and purged of all unused content including but not limited to line types, line styles, line weights, BIM objects views and drawings. All errors and warnings shall have been resolved or, if agreed to, listed on the approved BIM exception list. The detailing of 2D drawings shall be not less than the current practice used as tender drawings and working drawings. The final 2D drawings shall be generated from the BIM databases and aligned with specified required standards.

In the tendering stage, the tender information for the works contracts shall include BIM models with tender drawings generated from the BIM models including but not limited to the general layout plans, elevations, sections, details and schedules of architectural

drawings, framing plans, staircase sections, details and schedule of structural drawings, Combined Services Drawings (CSD) and Combined Builder's Works Drawings (CBWD), etc.

In the construction stage, drawings in the required file format shall be generated from the BIM models including but not limited to architectural drawings, structural drawings, CSD, CBWD and Reflected Ceiling Plans Drawings (RCPD), etc. to facilitate the coordination and operation for the construction works during the contract period.

As far as practicable, all 2D drawings shall be generated from the BIM authoring software and tools directly. Approval shall be sought from the Employer for the exemption of producing any drawings from BIM for example building services schematic / control logic diagrams / reinforcement rebar details / reinforced concrete details and other drawings that may solely require 2D details etc. A registration list shows the relationship between the BIM models and 2D drawings shall be created to indicate each 2D drawing that is generated from the BIM or not. Until the approval from the Employer is granted, all details with critical spatial coordination issue shall be modelled and represented in the shop drawings. Any 2D drawings are produced from non-BIM authoring software or tools that shall be prepared in accordance with the standard for 2D drawings as specified in the contract documents. In case any drawing is not created natively in the BIM authoring software it should be linked to the BIM database, so that it can be incorporated into the whole deliverable submission generated from the BIM database.

2.5 BIM Progress Reporting

A monthly BIM progress report shall be submitted at the end of each calendar month from first month of the commencement of the Contract to record the progress of all BIM tasks, including, but not limited to, BIM Project Execution Plan, modelling, completed tasks, upcoming tasks, records of progress/coordination meeting, all design changes, clash reports and all BIM deliverables. The report shall highlight all matters of issue or concern relating to the BIM.

2.6 Handover of BIM Deliverables

Work-in-progress (WIP) file(s) uploads shall not be counted as submission deliverable but shall be a proof of progress and for quality checking purposes. The WIP BIM shall also be presented during the BIM Progress / Coordination Meeting to facilitate decision making and communication with project stakeholders.

All final BIM, videos, federated models and non-graphical information developed for the project shall become the property of the Employer and transferred to the Employer on completion of the project. All BIM deliverables shall be unconditionally transferred and handed over to the Employer upon the completion of the design stage and construction stage or as and when requested by the Employer during the project.

3. Quality Assurance

3.1 Quality Assurance Plan

Quality Assurance plan shall be included in the BIM Project Execution Plan, outlining the quality assurance for the BIM process, BIM compliance and attributes for asset entries tracking. Quality assurance plan for BIM shall be established to ensure appropriate quality control on information and data accuracy.

The quality control measures to be included in the Quality Assurance Plan shall include, but not limited to the following contents:

1. model compliance according to the BIM Standards and modelling methodology which are stated in the BIM Project Execution Plan;
2. model quality according to the LOD responsibility matrix which is stated in the BIM Project Execution Plan;
3. data validation;
4. clash analysis checking; and
5. as-built verification such as laser scanning point cloud.

3.2 Design Review

In the design stage, design review shall be coordinated for stakeholders to provide their feedbacks to validate multiple design aspects by reviewing the models. The design review shall include but not limited to the following activities:

1. previewing space aesthetics and layout in a virtual environment;
2. reviewing different design options and alternatives;
3. evaluating effectiveness of design in meeting building program criteria.

3.3 Model Compliance Check

Model compliance checks shall include but not limited to the following:

1. format, such as software version and extension;
2. naming, such as naming of the files and their corresponding folders;
3. general settings, such as grid, survey point, project base point, shared coordinate and coordinate system, floor level, shared parameters, attributes;
4. consistency of 2D information generated from model;
5. attributes for asset entries tracking;
6. model cleanliness including flag links, unpurged elements and unused views in final model submission; and
7. compliance with the design.

3.4 Documentation Compliance Check

Documentation compliance checks shall be carried out to the BIM Project Execution Plans, federation maps, lists of self-check items, clash reports and model register list.

4. Training

4.1 Training Objectives

The training courses aim to enable the project participants to view, use and manipulate the BIM models and the BIM database in a systematic and effective manner.

4.2 Scope of Training

The project data should be used as the training materials. Training courses shall also cover but not be limited to the following:

1. the BIM authoring software and tools adopted in this Contract to enable the project participants to understand and familiarize with the operation, retrieval, modification, etc. of the BIM models;
2. the operation, retrieval of information and drawings and modification of the as-built BIM models for the Employer and parties involving in facilities upkeep of the project;
3. BIM project implementation;
4. BIM fundamentals and management of the CDE;
5. BIM data management - training including data quality verification processes and data exchanges; and
6. 4D modelling and 5D modelling.

4.3 Training Preparation

BIM training plan and training venue shall be approved by the Employer before the training. Each attendee shall be provided with a workstation with necessary BIM authoring software and tools and licenses for efficient hands-on exercise during the training.

4.4 Project Training Requirement

1. In the early design stage, project training course shall be provided to the project team including the Employer's staffs and the design consultants to demonstrate the information retrieval from the selected BIM authoring software, tools and CDE and the implementation of BIM standards, workflow and processes such as design coordination.

2. In the early construction stage, project training course shall be provided to the project team including the Contractor to deliver the similar contents.

3. Upon the completion of the project and handing over of the final as-built BIM models and deliverables, training course shall be provided to the Employer.

4. Training assessments shall be made and collected for revising the training materials and for the preparation of the next training classes

4.5 Personnel Training Requirement

1. The Consultant/Contractor is required to send his staff or sub-consultant/sub-contractor's staff to attend, suitable BIM skill training courses under the pre-approved list of the CITF managed by the CIC and ensure their successful completion of the attended training courses

2. In case there are sub-contractor(s)/sub-consultant(s) in the Assignment / Contract, the appropriate number of staff member from the sub-consultant(s) / subcontractor(s) should attend the BIM training.

3. In case the nominated staff members fail to complete the course, the Consultant/Contractor/Sub-consultant/Sub-contractor shall arrange additional BIM training courses to its staff members to fulfil the contract requirements at its own cost.

4.6 Training Log

Training Log for the BIM Training shall be submitted to the Employer for record after completion of the training courses. The training log shall list out the course information, including but not be limited to, description of the training course, date, duration, venue and attendee's name and position. The content of the training log shall be commented and agreed by the Employer. The training log shall be reviewed and updated.

5. Hardware and Software Requirement

5.1 Hardware and Software requirements in BIM Project Execution Plan

1. A technical/fee proposal shall be included on the hardware and software to produce and deliver the deliverables specified in Chapter 2 shall include both in technical and fee with details on specification and quantities of the BIM hardware and software to be used.

2. Free compatible standalone BIM viewers shall be proposed for viewing BIM deliverables.

3. All details on the compatible software and hardware (if any) to build up a CDE shall be included. A presentation with trial test of the proposed BIM software, tools and the CDE to the Employer shall be proposed with contents and schedule.

5.2 File Format and Interoperability

1. The BIM software for modelling shall support open Standards (include import and export file format not limited to IFC) and interoperability with other commonly adopted BIM authoring software in the Hong Kong construction industry as agreed by the Employer.

2. Native and Editable BIM models shall be submitted in an open format file through export from BIM authoring software when requested by the Employer.

3. Open format exported from BIM models include but not limited to:
    - Industry Foundation Classes (.ifc)

   Other file formats include but not limited to:
    - Video (H.264 & other formats specified in the latest version of OGCIO – The HKSARG Interoperability Framework (S18))
    - GIS data (.shp)
    - Plus other formats to be accepted by the Employer specified in the latest version of OGCIO – The HKSARG Interoperability Framework (S18)

4. All BIM deliverables shall comply with the approved software versions during the contract period and at the time of delivery

6. Common Data Environment (CDE)

6.1 Properties and Functions of CDE

A CDE required for storage, viewing and sharing of BIM deliverables such as BIM models, 2D drawings, rendering, images and other related files of the project. The CDE shall have the following properties and functions:

1. have a clear folder structure with access control that can be customised by administrative user, being part of the CDE to store various BIM related information;

2. support uploading, downloading, navigating BIM models and retrieving the attributes and data from the BIM models in the open BIM Standards Industry Foundation Classes (IFC) format on the CDE;

3. have file version/revision control;

4. provide the features to identify and compare design differences of the BIM models in different version/revision;

5. provide the feature to enable linkage between different BIM models, 2D drawings and project documents within the CDE;

6. have both mobile and web application interfaces;

7. contain encryption function for data security and be of sufficient capacity to store all files throughout the project design and construction stages;

8. be installed with anti-virus software and maintained with updated security patches for all software;

9. provide dashboards for presenting the BIM progress information to different level of users;

10. allow workflow for document submission and approval;

11. have the issue tracking system including the issue registration, logging, update and email notification;

12. provide off-site backup of all project BIM models, documents and data; and

13. maintain sufficient storage and be scalable to ensure it operates properly in both design and construction stages.

6.2 CDE requirements in BIM Project Execution Plan

The CDE approach shall be expressed in the BIM Project Execution Plan which shall include, but not limited to, the following:

1. Naming Convention.
   Model and object naming shall follow the specified BIM Standards and Guidelines including but not limited to the latest version from the CIC from time to time.

2. Version/Revision Control.
   It should be defined that the process of version/revision control for the project information under WIP to be shared, published and archived during each project stage.

3. Folder Structure.
   The data segregation, folder structure, processes and procedures to ensure proper information exchange between project stakeholders shall be proposed.

4. Access Control.
   An access control matrix shall be established that clearly specifies user access right of the folders and files.

5. BIM Collaboration Methodology and Workflow.
   The collaboration methodology and workflows shall be described including but not limited to the issue management and change management, communication protocols upon uploading, security and upload protocols (e.g. frequency and any deviations). CDE protocols and information exchange can reference to a similar process as described in ISO 19650-2:2018.

6. Model Information Sharing.
   A workflow of BIM information sharing to facilitate BIM Progress / Coordination Meetings shall be set up.

7. Project Archive.
   CDE data shall be archived in Employer's preferred media and transferred to the Employer upon the completion of the design stage and construction stage respectively or as and when requested by the Employer during the project.

6.3 CDE Implementations

The CDE shall be implemented within 1 month upon approval by the Employer, and be utilised throughout the project stages. TWO (2) nos. of login account for the Employer and sufficient nos. of login account for the involved parties of the project team for CDE shall be provided from design stage to construction stage.

7. BIM Standards and Guidelines

The BIM Standards and Guidelines listed in **Appendix 3,** and any updated version of which, shall be complied.

Appendix 1 Outline of BIM Project Execution Plan

The Project Execution Plan shall include but not limited to the following sections:

1. BIM Project Execution Plan Overview
2. Project Information
3. Employer BIM Requirements
    - 3.1. BIM Goals and Objectives
    - 3.2. BIM Uses
    - 3.3. BIM Interoperability
    - 3.4. BIM Data
    - 3.5. LOD Definitions
    - 3.6. LOD Specification
    - 3.7. LOD Responsibility Matrix
    - 3.8. Meeting Schedule
4. BIM Management
    - 4.1. Roles, Responsibilities and Authority
    - 4.2. BIM Team Resources, Competency & Training
    - 4.3. BIM Deliverable Schedule (Programme)
    - 4.4. Approval of BIM Deliverables
5. BIM Process
    - 5.1. Individual Discipline Modelling
    - 5.2. Model and Information Sharing
    - 5.3. BIM Coordination and Clash Detection
    - 5.4. Drawing Production
    - 5.5. Model Archive
    - 5.6. Quality Control and Quality Assurance
6. BIM Standards & Procedures
    - 6.1. BIM Origin Point, Coordinate System & Orientation
    - 6.2. Modelling Methodology and Model Federation
    - 6.3. Model Structure/Hierarchy and Division
    - 6.4. Model Units
    - 6.5. File Naming Convention
    - 6.6. Naming Convention of Information Containers within BIM database
    - 6.7. Drawing Sheet Templates
    - 6.8. Annotation, dimensions, abbreviation and symbols
    - 6.9. Colour Scheme
7. Technology Platform, Hardware & Software Solutions
    - 7.1. CDE
    - 7.2. Software Versions
    - 7.3. Exchange Formats
    - 7.4. Data Security & Back-up
    - 7.5. Hardware Specifications
    - 7.6. IT Upgrades
8. BIM for AM/FM
9. Risk Management in BIM adoption

Appendix 2 Guidelines for As-built BIM Model

The As-built BIM models shall be prepared in accordance with the Employer's BIM Guide for Facilities Upkeep in which the BIM Guide will be provided and instructed by the Employer in the construction stage.

The As-built Model and 2D as-built record drawings shall comprise customised building attributes and file structure for data submission in format agreed and approved by the Employer. The as-built model and building attributes will be used for future development on retrieval of asset and works records mapping in Employer's AM/FM system which will be BIM-enabled.

The As-built Model shall be provided with an open BIM Standards IFC format for viewing and integration with the Employer's AM/FM. The BIM data shall be in HK1980 Grid Coordinates System and refer to Hong Kong Principal Datum. The data format shall be compatible with the IFC standard (IFC4 or alternative advance format as requested by the Employer). Coordination with the Employer's representatives and their information technology vendor is required to further proceed data conversion process to the submitted native BIM model and IFC file for data conversion to the Employer's AM/FM application and commonly adopted GIS platform in Hong Kong. Relevant schedules and contract documentations stored in pre-defined folder structure shall also be arranged to suit the file display / downloading functions in the Employer's AM/FM.

The IFC files shall be submitted for the Employer's AM/FM integration under different detail levels agreed by the Employer. The original as-built Model files shall also be submitted to the Employer for examination and data conversion purpose. The objects of the As-built Model shall contain the attributes and properties as required by the Employer. Subject to the complexity of the project, the required attributes and properties shall be fine-tuned on request by the Employer.

It is required to work with and provide training to the Employer's staffs including the project team members, estate office management / facility operation and maintenance teams and their information system vendor(s) to ensure the As-built Model smoothly integrated with the AM/FM. The As-built Model shall be provided with files with 3D animation showing the assembly, disassembly, repair and replacement method for special component or special building system such as curtain wall system, facade, prefabricated, MiC*, DfMA* units / elements, etc. for viewing in the Employer's AM/FM.

The As-built Model shall be able to create sheet records and contain information including photographic record, 3D digital point cloud from field verification such as laser scanning and other data to meet the requirements indicated in Employer's BIM Guide for Facilities Upkeep. For the As-built BIM Model for building services installations shall also make reference to the information requirements of the Building Information Modelling for Asset Management (BIM-AM) Standards and Guidelines issued by Electrical and Mechanical Services Department.

Appendix 3 BIM Standards and Guidelines

1. Building Information Modelling Standards - General, August 2019, by the Construction Industry Council in Hong Kong;
2. Production of BIM Object Guide – General Requirements, August 2019, by the Construction Industry Council in Hong Kong;
3. Building Information Modelling Standards for Mechanical, Electrical and Plumbing, August 2019;
4. Building Information Modelling Standards for Underground Utilities, August 2019;
5. Guidelines for Using Building Information Modelling in General Building Plans Submission, 2019
6. BIM related Technical Circulars from the Development Bureau of the HKSARG;
7. Building Information Modelling for Asset Management (BIM-AM) Standards and Guidelines, version 2.0, 2019 issued by the Electrical and Mechanical Services Department (EMSD);
8. Common Spatial Data Infrastructure requirements, Open Geospatial Consortium Standards CityGML and specifications, or the like published / released from the Works Departments of the HKSARG from time to time;
9. ISO 19650-1:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) -- Information management using building information modelling -- Part 1: Concepts and principles, edition 1, December 2018, by the International Organization for Standardization;
10. ISO 19650-2:2018: Organization and digitization of information about buildings and civil engineering works, including building information modelling -- Information management using building information modelling -- Part 2: Delivery phase of the assets, edition 1, December 2018, by the International Organization for Standardization;
11. BIM Standards and Guidelines by the CIC / Buildings Department for Statutory Plan Submission such as General Building Plan;
12. AEC (UK) BIM Technology Protocol Practical implementation of BIM for the Architectural, Engineering and Construction (AEC) industry, version 2.1.1, June 2015, by the AEC (UK);
13. BIM Project Execution Planning Guide, version 2.1, May 2011, by The Computer Integrated Construction Research Program of the Pennsylvania State University;
14. BIM Project Specification, revision 3.0, Jun 2011, by the Hong Kong Institute of Building Information Modelling;
15. Building Information Modelling (BIM) Guide for Building Services Installation (Version 1.0) issued by Building Services Branch (BSB), Architectural Services Department;
16. BIM Guide for Facilities Upkeep (version 1) issued by Property Services Branch (PSB), Architectural Services Department;
17. Drafting Specification for Engineering Survey;
18. BS 1192:2007 Collaborative production of architectural, engineering and construction information. Code of practice;

19. PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling;
20. PAS 1192-3:2014 Specification for information management for the operational phase of construction projects using building information modelling;
21. PAS 1192-5:2015 Specification for security-minded building information modelling, digital built environments and smmt asset management;
22. BS 1192-4:2014 Collaborative production of information. Fulfilling employer's information exchange requirements using COBie. Code of practice.