

## **BUILDING INFORMATION MODELLING (BIM) PROJECT REQUIREMENTS**

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## **BUILDING INFORMATION MODELLING (BIM) PROJECT REQUIREMENTS**

### **1.0 GENERAL**

- 1.1 The Contractor shall ensure the use of Building Information modeling (BIM) in the project and work closely with the Consultants and its subcontractors to facilitate the BIM implementation process in the project.

### **2.0 BIM GUIDELINES**

- 2.1 The Contractor shall make reference to the latest version of the following BIM guides, for definitions, specifications and guidelines on BIM model creation, coordination and applications in the construction:
- a) SIT's Employer's Information Requirements (EIR)
  - b) Singapore BIM Guide
  - c) BIM Essential Guide For Contractors
  - d) BIM Essential Guide for Collaborative Virtual Design and Construction
- 2.2 For conflicts and/or discrepancies between the BIM Project Requirements the above mentioned guidelines the more stringent requirement shall take precedence.
- 2.3 For the avoidance of doubt, the BIM Terms of Reference shall also form part of the Agreement between the Employer and the Contractor.

### **3.0 BIM EXECUTION PLAN**

- 3.1 BIM Execution Plan is a document that lays out how BIM will be implemented on a particular project as a result of the collective decision by the members of that project.
- 3.2 The purpose of the BIM Execution Plan is to outline the processes, workflows and timelines in which BIM will be implemented throughout the project lifecycle. All project participants will maximize the use and take full advantage of BIM for the purpose of the project and enhance team collaboration and coordination.
- 3.3 The BIM Execution Plan shall include but not limited to the following:
- a) Project information;
  - b) BIM goal and uses;
  - c) Each Consultant and Contractor's roles, staffing and competency;
  - d) BIM process and strategy;
  - e) BIM exchange protocol and submittal format;
  - f) BIM data requirements;
  - g) Collaboration procedures and method to handle shared models;
  - h) Quality control and compliance to BIM Requirements
  - i) Technology infrastructure and software.
- 3.4 The appointed BIM Manager and BIM Coordinator(s) of the project shall work together to develop, update and implement the BIM Execution Plan in accordance to the BIM Requirements and Employer's Information Requirements (EIR).

- 3.5 The Construction BIM Execution Plan shall be submitted to the Superintending Officer within 2 weeks award of contract, for approval.
- 3.6 Modifications to the terms of the BIM Execution Plan shall be submitted to the Superintending Officer immediately for review and acceptance, at times as indicated by the Superintending Officer.
- 3.7 The Contractor shall have at its own cost, obtain competencies to furnish a monthly report, that includes the updating of Contractor's Construction Model and/or As-Built Model, Monthly BIM Construction Schedule Simulation analysis of the entire project lifecycle (planned versus actual), BIM trade Coordination (Between contractors and their subcontractors) Report and BIM model, As-Built documentations, as part of their monthly project update.
- 3.8 The project BIM Manager shall timely update and submit BIM progress report and finally BIM handing over report in a format and at a frequency to be determined with the Employer.
- 3.9 The BIM Manager shall prepare and implement any other additional goals and uses as deemed necessary in order to achieve the Employer's Information Requirements.

#### **4.0 BIM MANAGER**

- 4.1 The Contractor shall appoint a full time qualified BIM Manager to manage and coordinate the overall use of BIM for the project, including the implementation of BIM in construction process as well as preparation of As-Built Models and other deliverables as defined in Annex A - BIM Objectives and Responsibility Matrix.
- 4.2 The BIM Manager shall undertake the role and responsibility as stipulated in the latest version of the Singapore BIM Guide and Employer's Information Requirements (EIR) unless expressly agreed otherwise in the BIM Execution Plan.
- 4.3 The Contractor to ensure that the appointed BIM Manager is fully competent to deliver the high standard of BIM and Virtual Design and Construction (VDC) implementation required, and has the sufficient skills and experience to lead, manage and perform this standard of work.
- 4.4 The BIM Manager shall have a minimum ten (10) years construction experience, five (5) years of BIM management and coordination experience and shall possess a BCAA Specialist Diploma in BIM or equivalent.
- 4.5 The BIM Manager shall be supported by a full time team of BIM Coordinators and Modelers as laid out in the BIM Execution Plan, to ensure smooth and controlled delivery of all BIM contractual work according to the approved schedule, BIM goals and objectives.
- 4.6 For the avoidance of doubt, all compensation and related costs associated with the appointment of BIM Manager in connection with work to be done in the Project are to be borne by the Contractor, and no reimbursement, compensation and/or related costs whatsoever shall be paid to the Contractor for this requirement.

## **5.0 BIM COORDINATOR(S)**

- 5.1 The Contractor shall appoint at minimum two (2) BIM Coordinators for each discipline to coordinate among the consultants (including subcontractors and suppliers) for the project.
- 5.2 The BIM Coordinator(s) shall undertake the role and responsibility as stipulated in the latest version of the Singapore BIM Guide and Employer's Information Requirements (EIR) unless expressly agreed otherwise in the BIM Execution Plan.
- 5.3 The BIM Coordinator(s) shall have a minimum five (5) years of BIM coordination and modeling experience and shall possess a BCAA Specialist Diploma in BIM or equivalent.
- 5.4 The Contractor BIM team shall be subjected to the Superintending Officer's approval. For the avoidance of doubt, all compensation and related costs associated with the appointment of BIM Coordinator in connection with work to be done in the Project are to be borne by the Contractor, and no reimbursement, compensation and / or related costs whatsoever shall be paid to the Contractor for this requirement.

## **6.0 BIM DELIVERABLES**

- 6.1 The Architect, Structural Consultants & MEP Consultants involved in the project shall provide the Final Design Model to the awarded Contractor in native format. For the avoidance of doubt, the Final Design Model handed over to the Contractor is for reference only. The Employer and his consultant team shall not be liable for any inaccuracies of the Final Design Model at any stage.
- 6.2 The Contractor is expected to develop / generate the necessary Model suitable for Construction Document, Shop Drawings, fabrication and final Handover to the Superintending Officer. Typical details may be represented in 2D CAD drawings to complement the models, these shall be contained inside the model files.
- 6.3 The base Construction Document, Shop Drawings and other Drawings shall be derived from the Construction Models, these drawings can be further enhanced and developed to suit the presentation requirements for deliverables and at every BIM meeting. The contractor also shall be liable for any construction errors due to the inaccuracy of the Model.
- 6.4 The Contractor is expected to coordinate the model progressively by zones, by floor or equivalent method. All design changes due to variations and etc. may be first incorporated accordingly to relevant 2D drawings. The Contractor shall be responsible for the full accuracy, coordination and the transfer of all information from 2D drawings and models provided by Design Consultants to the "Construction Model".
- 6.5 The appointed BIM Manager shall ensure the submission of the proposed BIM deliverables with delivery dates. The Contractor shall prepare the BIM deliverables as indicated in the Annex A - BIM Objectives and Responsibility Matrix and in reference to the Employer's Information Requirements (EIR). In general, BIM deliverable shall include a set of digital representation of the project in the form of

drawings, BIM models and non - geometrical data that describe the physical, functional and performance characteristics of the project for the purpose of planning, documentation, visualization, simulation, analysis, collaboration, facility management and operation throughout the project lifecycle. The following models of various project stages and other outputs should be included in the deliverables:

- a) Construction models
- b) Coordination model for clash detection and model-based schedule simulation (4D Simulation)
- c) Fabrication drawings from the model (if applicable)
- d) Model generated shop drawings (if applicable)
- e) As-built models (in both native proprietary and open BIM formats) with Facilities Management requirements as listed in Annex A - BIM Objectives and Responsibility Matrix and in reference to the Employer's Information Requirements (EIR).

- 6.6 The appointed BIM Manager shall prepare a program schedule indicating BIM related activities and milestones. This program shall be synchronized with the Contractors Master Program and reported at every site meeting. The Contractor shall model existing facilities that interface with the Project unless otherwise stated by the Superintending Officer, to address potential interferences at the areas of interfaces.
- 6.7 The Contractor shall produce, update, submit and share BIM Deliverables in accordance to the requirements, times and receiving parties as documented in the BIM Execution Plan.
- 6.8 The Contractor is to submit the developed Model to the respective Consultant and Superintending Officer's BIM Team for checking at agreed milestones. Submission milestones shall be indicated clearly in Contractor's BIM Execution Plan.
- 6.9 The BIM Deliverables shall be prepared in the prevailing version as stipulated in the BIM Execution Plan and subject to Superintending Officer's approval.

## **7.0 BIM MODELING REQUIREMENTS**

- 7.1 The Contractor shall refer to the latest version of the Singapore BIM Guide and Employer's Information Requirements (EIR) for general modeling guideline and requirements, including but not limited to the following:
  - a) Model Orientation and Site Configuration: The origin point for the project should be clearly defined and drawn in the SVY21 coordinate system and with reference to the SLA Vertical Control Point (VCP) (>100M) plus 100m. The model orientation and site configuration shall be documented in the BIM Execution Plan.
  - b) Model Division and Structure: Necessary model division due to the size of the model files and corresponding structure shall be agreed by the project parties and documented in the BIM Execution Plan as early as possible. Any modification in the agreed model division shall be submitted to the Superintending Officer for review and approval.

- c) **Model Revision Management:** The BIM Manager and the BIM coordinators for individual disciplines shall work with their respective BIM vendors to familiarize themselves with the use of the software's mechanisms to manage design changes effectively and maintain a register to record and to report on the latest information and changes incorporated in the model.

- 7.2 **Requirements for BIM Elements:** All BIM elements and attributes to be modeled shall be properly defined in the data requirements of the BIM Execution Plan. The required BIM elements shall include, but not limited to the typical BIM elements specified in the Appendix A of the Singapore BIM Guide Version 2.
- 7.3 The appointed BIM Manager and BIM Coordinators shall propose and ensure those attributes relevant to asset and facility management are all included where applicable and practical, or the appointed BIM Manager and BIM Coordinators shall seek the Superintending Officer's approval for exclusion of any of those applicable attributes and property sets with acceptable reasons.

## 8.0 LEVEL OF DETAIL

- 8.1 The Contractor shall ensure the BIM model is in full compliance to the specified Level of Detail (LOD) and Level of Information (LOI). The specified LOD and LOI shall take precedence over other relevant requirements as stipulated in the tender document, unless there is relevant and latest authority requirements (which require the contractor to provide BIM model with specified or higher level of LOD and LOI).

	<b>Schematic Design</b>	<b>Design Development</b>	<b>Tender Documentation</b>	<b>Contract Construction</b>	<b>Final Completion</b>	<b>Operation</b>
<b>RIBA Stage of Work</b>	0 - 2	3 - 4	N/A	5	6	7
<b>LOD</b> (BIM Forum 2018)	100	200	300	300 - 400	500	500
<b>LOD</b> (AEC UK)	2	3	4	5	6	6
<b>LOD*</b> (NBS BIM Toolkit)	1	2	3	3 - 4	5	5
<b>LOI*</b> (NBS BIM Toolkit)	2	3	4	5	6	6

## 9.0 COORDINATION / CLASH DETECTION

- 9.1 The Contractor shall use BIM Models for coordination on all regular technical or site meetings to resolve queries or any RFIs raised during this phase and fully coordinating the 3D model with all applicable parties. BIM Manager shall report, track and lead this coordination and interference checks at every regular technical and site meetings.
- 9.2 The Contractor's BIM Manager shall initiate and organize BIM Meeting with the required Discipline Consultants / sub-contractors to fully resolve any technical BIM related issues.
- 9.3 The Contractor's BIM Manager shall propose protocols on raising RFI including the process, frequency, and formats.
- 9.4 The Contractor shall require all sub-contractors to submit all models to the Contractor. These models should be updated after each project coordination meeting or as changes occur in the field during construction. In the event the subcontractor, fails to deliver their respective models submission in the required satisfactory and timely manner, Contractor shall be fully liable and shall be responsible to immediately take over their scope and at his own cost and time expense, to deliver according to the required quality and timeline.
- 9.5 The Contractor's BIM Manager shall assemble a Coordination Model from all of the model parts of each design discipline for the purpose of performing a visual check of the building design for spatial and system coordination. Prior to each scheduled coordination meeting, an updated clash report will be issued by the BIM Manager to each technical discipline consultants.
- 9.6 It is the Construction Team's responsibility to conduct and manage an adequate and thorough Clash Detection process so that all major interferences between the building components will have been detected and resolved before construction.
- 9.7 The Contractor is responsible for resolving all conflicts and fully coordinating the 3D model with all applicable parties throughout all stages of the project, and in accordance to the approved schedule. The Contractor's BIM Manager shall provide clash detection reports in the agreed sequence and format, at least for each floor prior to the construction to assist the coordination process.
- 9.8 The Contractor' BIM Manager shall provide a report highlighting detected (hard and soft) collisions and identifying those collisions that require further work by the project team. If required, it is the responsibility of the Contractor to provide the report in a format with the appropriate 3D and 2D drawings to enhance understanding and resolution by the project team, and with proposals / options for resolution, all at contractor's own time and cost.
- 9.9 The Models may need to be spilt on a level-by-level basis for coordination. If a floor is particularly large, it shall be split by zones to reduce file size, to ensure that any reviews by Employer / Superintending Officer shall be implemented and presented, with minimal lagging or waiting times. Any preparation work for such Employer / Superintending Officer reviews shall be performed by the Contractor prior to the

meeting / review session.

- 9.10 Coordination software shall be used for assembling the various design models to electronically identify, collectively coordinate resolutions and track and publish interference reports between disciplines. The Contractor shall be responsible for timely updating their models to reflect all the coordinated resolution, all to Superintending Officer's approval.
- 9.11 Due to the expected number of clashes, BIM Manager shall strategize and propose how to manage and categorize clashes based on priorities and significance to construction, sequence, such that the Superintending Officer's BIM discussions and reviews shall be time and content-efficient.

## 10.0 4D SCHEDULING

- 10.1 The Contractor to provide a simulation of the construction sequence of all major works for analysis and presentation purposes. This include but not limited to the following:
- a) Full virtual construction sequencing mapped against in-progress construction status
  - b) Trade and work area sequencing
  - c) High level of detail fit out sequence
  - d) Major equipment installation and repair / replacement sequencing such as chiller plant room, ACMV equipment, HT & LT switch room, transformer room, etc
  - e) Logistic / site planning
- 10.2 The 4D model shall be updated on a regular basis whenever there are significant changes to construction schedule or whenever deemed necessary, and accepted by Employer / Superintending Officer. The format will be delivered as an AVI (Audio Video Interleaved) file format.

The primary elements are required for 4D simulation and sequencing, but not limited to the following:

SYSTEMS	DESCRIPTIONS
Structural System	All structural framing components including foundation, beams, columns, load bearing walls, floor slabs and roof decks and support.
Exterior Building Envelope	Stud Walls, Exterior Panel and assemblies, curtain walls, openings, glazing and etc.
Interior Works and Partitions	Interior walls and wall assemblies
Roof & Skylight System	Roof assemblies and openings.
Site Work and Ground Plane	Excavation work, footings, foundation, on-grade slab.
MEP System	Major MEP system, equipment, tanks and towers.
Logistics	Large vehicular & Equipment access and Holding zones, Material logistics, crane position
Construction Phasing /	Hoarding, access routes & scheduling, design for



Authorities	safety scheduling.
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## 11.0 BIM SYSTEM SETUP

- 11.1 The Contractor shall have or obtain, at his own cost, all the hardware, software and trained personnel needed to successfully implement BIM for the project.
- 11.2 The BIM setup to meet the BIM contract requirements and as proposed by the BIM Manager and BIM Coordinators as stated in the project's BIM Execution Plan shall be capable for development of construction models and final as-built models, so as to achieve the Project's deliverables and shall be compatible and interoperable when used in the Project. In order to ensure that all Models are accessible at all times, the system shall have minimal disruption for this Project. Contractor shall ensure that BIM System is available for use during coordination meetings.
- a) Workstation
- The application of BIM for the project will require workstations with adequate performance and capacity to run the designated BIM software, connected to each in a network environment via a central hub. Contractor to ensure workstations in good working condition and performance, and accordance to the BIM specification laid out in this Contract.
- b) BIM Discussion Room
- An air-conditioned room that is well lit and will comfortably fit a minimum of thirty (30) people and equipped with the workstations and accessibility to required Model through network. The discussion room should also be equipped with the necessary communication devices and projection facilities, all fully serviced and in working order at all times.

## 12.0 BIM APPLICATION AND SOFTWARE

- 12.1 The set of BIM applications and software proposed by the appointed BIM Manager and BIM Coordinators shall be able to fully meet the Project's objectives and shall have minimal compatibility and interoperability issues when used in the Project.
- 12.2 The appointed BIM Manager and BIM Coordinators shall reach a consensus with each other and all the parties in the BIM Execution Plan on the type and version of BIM applications and software to be used in the Project, for the Superintending Officer's approval, before the commencement of the Project.
- 12.3 The following BIM software shall be used for this project unless otherwise agreed upon and approved by Superintending Officer. Contractor shall ensure compatibility of the BIM applications to be used in the project. Should a party required different BIM application, BIM Manager shall be notified and update software list in the BIM Execution Plan and approval obtained.

APPLICATION AREA	SOFTWARE TOOL
Authoring and Design – Architecture	Autodesk Revit 2017
Authoring and Design – Structural	Autodesk Revit 2017
Authoring and Design – MEP	Autodesk Revit 2017
Coordination (spatial conflict & clash detection)	Navisworks Manage 2017
4D Scheduling	Navisworks Manage 2017 / Synchro Pro & Primavera / Microsoft Project or equivalent

### 13.0 BIM INTEROPERABILITY

- 13.1 To implement an open BIM strategy and enable Employer's access to BIM data over the construction lifecycle, the Contractor shall ensure necessary interoperability strategy and develop the model in compliance to the latest version of the IFC open BIM format as a minimum requirement, unless expressly agreed otherwise in the project's BIM Execution Plan and approved by the Superintending Officer.

### 14.0 MODEL DELIVERY

- 14.1 Upon the completion of each stage and / or phase of the Services, the Contractor's BIM Manager shall facilitate the transfer of any model produced by the Contractor to the Superintending Officer.
- 14.2 The Contractor shall submit three (3) copies of all models and relevant documents and drawings in softcopies or in such media, eg. on CDs, and track every submission as may be required by the Employer. It is the Contractor's BIM Manager's responsibility to ensure the delivery of all stages of the Construction Model and the As-Built Model in fully accordance to all requirements stipulated in this document.

### 15.0 BIM QUALITY ASSURANCE

- 15.1 The appointed BIM Manager and BIM Coordinators shall ensure that the BIM Deliverables meet the quality assurance guidelines as stated in the latest version of the Singapore BIM Guide. Deviation(s), if any, shall be outlined in the BIM Execution Plan, subject to the Superintending Officer's approval.

### 16.0 OWNERSHIP AND RIGHTS TO BIM DELIVERABLES

- 16.1 The Employer shall have the ownership and exclusive rights to all BIM Deliverables of the Project unless otherwise agreed by the parties.
- 16.2 The Employer has the right to grant its appointed agents the rights to use the BIM Deliverables for the purpose of the Project and subsequent operation and maintenance of the Works at his discretion.

**Annex A - BIM Objectives and Responsibility Matrix**

BIM PROJECT OBJECTIVES	DELIVERABLES	Project members involved in fulfilling the BIM objective.  A – model author; U – model users R – model reviewer					
		ARCH	STRUCT	MEP	QS	EMPLOYER	CONTRACTOR
<b>Construction</b>  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.  Notes: - The Contractor shall be solely responsible for claims and liability arising from the use of or access to the BIM Model as provided under this stage.  - The Design Intent BIM Model shall progressively be updated by the Contractor throughout the Construction Stage; capturing all relevant changes, documenting and building up the necessary level of detail to in order to carry out the required project deliverables.  - The Contractor shall make full use of the latest Construction BIM Model and shall derive drawings and other documentation materials (2D/3D/4D etc.)							
1. Produce Construction Models from Architectural, Structural and MEP Models. The models will be produced in stages.	Construction Models with Key Services Coordinated	U	U	U	U	R	A
2. Implement construction design and coordination between the Architectural, Structural and MEP Models:  • Identify element conflicts and interferences • Address penetration conflicts • Verify valid headroom and working spaces for building operations and maintenance activities for all areas	• Clash Detection & Resolution Report  • Spatial Validation Report						
3. Produce schedules of materials, areas and quantities from the BIM databases for the Contractor's reference.	Schedules of materials, areas and quantities	U	U	U	U	R	A

BIM PROJECT OBJECTIVES	DELIVERABLES	Project members involved in fulfilling the BIM objective. A – model author; U – model users R – model reviewer					
		ARCH	STRUCT	MEP	QS	EMPLOYER	CONTRACTOR
4. Sub-contractors and specialist sub- contractors will generate documents based on the Construction Models.	<ul style="list-style-type: none"> <li>• Shop drawings</li> <li>• Combined Services Drawings (CSD)</li> <li>• Single Services Drawings (SSD)</li> </ul>	U	U	U	U	R	A
5. Produce 4D simulation to visualize construction schedule, methodology, and track construction progress. Utilize the information to validate and make informed decision that will improve project timeline efficiency in all areas. These include: <ul style="list-style-type: none"> <li>• Full virtual construction sequencing mapped against in-progress construction status</li> <li>• Trade and work area sequencing</li> <li>• High level of detail fit out sequence</li> <li>• Major equipment installation and repair / replacement sequencing such as chiller plant room, ACMV equipment, HT &amp; LT switch room, transformer room, etc</li> <li>• Logistic / site planning</li> </ul>	<ul style="list-style-type: none"> <li>• 4D simulation</li> <li>• Other reports and monitoring for all items' resolution</li> </ul>						
6. Generate walk-through simulations to visualize and document critical areas of the development as part of coordination report, for review.	<ul style="list-style-type: none"> <li>• Walk / fly through in AVI format on predetermined approved path</li> </ul>						

BIM PROJECT OBJECTIVES	DELIVERABLES	Project members involved in fulfilling the BIM objective. A – model author; U – model users R – model reviewer					
		ARCH	STRUCT	MEP	QS	EMPLOYER	CONTRACTOR
7. Where an amendment submission is required from the Consultants, the Contractor(s) should provide the latest record model and drawings to the Consultant whenever requested during the Construction stages.	<ul style="list-style-type: none"> <li>Record model</li> <li>Record model – generated drawings</li> <li>Other non-BIM deliverables</li> </ul>	U	U	U	U	R	A
8. Generate, freeze and store final documentation of the authorised BIM model in the Construction phase before progression into the as-built phase.		U	U	U	U	R	A
<b>As-Built</b>  BIM element is similar in level of detail to the Detailed Design stage, but updated with changes during Construction Stage.							
9. The Contractor(s) will prepare the as-built BIM Model to reflect amendments in the Architectural, Structural, MEP BIM models and the completed form of the construction is to be verified before submitting to the Consultants.	Final as-built models for each discipline	U	U	U	U	R	A
10. Consultants to confirm that the as-built Models are in accordance with the BIM Models, corresponding to the final approved amendment plans submitted to the relevant Authorities.		A	A	A	U	R	U

BIM PROJECT OBJECTIVES	DELIVERABLES	Project members involved in fulfilling the BIM objective. A – model author; U – model users R – model reviewer					
		ARCH	STRUCT	MEP	QS	EMPLOYER	CONTRACTOR
<b>Facility Management</b>  BIM element is modelled as an actual constructed building component or system and is an as-built representation of the actual completed building.							
11. Incorporate non-geometry equipment information under the COBIE standard in the as-built BIM model elements for provision to the Facility Manager (FM).	Final as-built models fit for space management, building maintenance & modifications made during occupancy by the facility management	U	U	U	U	R	A

## **Annex B - Virtual Design and Construction (VDC) and Integrated Digital Delivery (IDD) Adoption**

### **1. Adoption of Virtual Design and Construction (VDC) methodologies in the BIM process:**

The Contractor shall adopt and carry out Virtual Design and Construction (VDC) as an integrated approach that combines BIM and advanced management methods to improve productivity. Specifically, it is intended to increase profitability, improve reliability and predictability before project execution and enhance project efficiency to higher levels. The Contractor shall fully familiarize himself with BCA's Guidelines and shall lead and implement VDC methodologies in the whole construction process and demonstrate the measurable productivity KPI increases for the various VDC methodologies. The VDC methodologies which he will employ shall include but shall not be limited to:

- a) **VDC Schedule tied to the Master Construction Schedule** - The Contractor shall provide a VDC Schedule tied to the Master Construction Schedule. He shall detail out specifically each area of Productivity increase, document and track the activities and issues therein, and report these at each BIM / VDC Meeting.
- b) **Coordination & ICE Meetings** – The Contractor shall perform collaborative work together with all trade personnel to identify critical issues that need to be resolved before the actual construction. Throughout the construction period, the Contractor shall continuously document and track all types of issues raised and the time taken for each resolution to demonstrate the productivity increase. The Contractor shall fully and effectively utilize the BIM model from project commencement until project completion.
- c) **Virtual Planning & Virtual Mock-up** – At the early stage of construction, the Contractor shall develop virtual mock-ups for all relevant areas of the project. The virtual mock-ups must be modeled to a minimum LOD400 for constructability study. Using the same virtual mock-up, the Contractor shall demonstrate detailed sequencing of components therein to convey the actual installation sequence, and to correlate these to actual site deliveries, installation and finishing data, with verification sign-off from the Contractor's Project Manager.
- d) **Innovation** – The Contractor shall adopt innovative technologies and digital solutions to supplement the efficient delivery of the project.
  - Enhanced Visualisation through Virtual Reality (VR)
  - Digital Reality Capture, use of drones and laser scanning for reliable reporting of construction progress and as-built information.
  - BIM to Field, translation of digital information to actual field data (e.g. Robotic Total Station, etc.)
  - Digital Construction Management Tools for quality and defects management