

Integrated Digital Delivery (IDD) Requirements

A guide to prescribe essential IDD requirements
for a typical project

April 2024

Preface

What this Guide is about

This guide aims to assist the employer in defining Integrated Digital Delivery (IDD) requirements clearly for their projects. It outlines the key components of IDD requirements for a typical project. It also provides sample IDD requirements clauses for the employer to incorporate in their tenders.

How this Guide is organised

This guide has two (2) sections and two (2) appendices as follows:

- Section 1 provides an introduction to IDD.
- Section 2 describes a set of essential IDD requirements, which include three key components, namely,
 - (i) Common Data Environment (CDE), IDD use cases and enabling technologies
 - (ii) Roles and responsibilities of project stakeholders involved in implementing IDD; and
 - (iii) A set of IDD deliverables.
- Appendix A provides sample clauses on IDD Requirements which may be included in the tender.
- Appendix B provides sample clauses on tenderers' submission requirements, which may be incorporated in the Instructions to Tenderers, to allow the employer to evaluate tenderers' digital competencies as part of the tender evaluation process.

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SECTION 1 – INTRODUCTION OF INTEGRATED DIGITAL DELIVERY (IDD)

1.1 What is IDD

IDD is the use of digital technologies to integrate work processes and connect stakeholders working on the same project throughout the project lifecycle. This includes design, fabrication, construction, as well as the operations and maintenance of buildings.

1.2 Why firms should adopt IDD

IDD promotes efficient communication and collaboration among project stakeholders with the adoption of digital technologies, which leads to better coordination, reduced errors and improved project outcomes. It also facilitates near real-time access to project data, allowing for more informed decision-making throughout the project lifecycle.

1.3 How to Adopt IDD for Project

Employers can reference or modify the sample IDD clauses found in Appendix A for incorporation into their contracts with the contractors.

Besides specifying well-defined IDD requirements under the contract, an employer should also evaluate a tenderers' IDD proposals and digital competencies during tender evaluation (see tenderers' submission requirements in Appendix B), and verify a contractor's digital deliverables during the project implementation period. The employer may wish to assign an in-house team or appoint an IDD consultant to assist them in these tasks.

Upon project award, the awarded contractor should carry out the following tasks:

1. Establish an IDD implementation plan covering the workflows and the digital technologies for each digital use case and the roles and responsibilities of all project stakeholders to meet the IDD requirements; Implement digital technologies that aligns with the project's specific needs and set up digital platform to facilitate collaboration and data management throughout the project lifecycle;
2. Execute IDD use cases according to the approved IDD implementation plan throughout the project lifecycle; and
3. Collect data using digital platform to aid decision making and project performance monitoring.

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SECTION 2 – COMPONENTS OF IDD REQUIREMENTS

To successfully execute an IDD project, first and foremost, the employer should specify the following requirements clearly in the contract:

1. CDE, IDD Use Cases and Enabling Technologies;
2. Roles & Responsibilities of project stakeholders in implementing IDD; and
3. IDD Deliverables.

2.1 CDE, IDD Use Cases and Enabling Technologies

- (i) Common Data Environment (CDE) – a centralised digital platform used for the collection, management & dissemination of project-related information. It functions as a single source of truth and ensures all project stakeholders have access to the most up-to-date and accurate information. This would enhance collaboration among project stakeholders through the project lifecycle;
- (ii) IDD Use Cases – a set of specific applications of digital technologies to integrate and optimise work processes and connect project stakeholders throughout the project lifecycle;
- (iii) Enabling Technologies – a range of software applications and technologies utilised to support and enhance various aspects of project management and execution. It plays a crucial role in implementing the CDE and various IDD use cases.

2.1.1 Common Data Environment (CDE)

The CDE platform plays a critical role in Information management for the project. It is therefore important to specify the CDE requirements clearly in the contract to ensure the integrity, authenticity, confidentiality and security of the information stored in CDE. The platform should adopt international best practices¹ for information management and cyber-security control measures.

The employer should require a CDE to be put in place for project collaboration. The CDE should minimally have the following features:

- Capture, store, manage (including versioning), share, export, import and archive all project-related information;
- Manage the access rights of the project stakeholders to specific information;
- Set up workflows to manage quality and distribution of information;
- Create digital forms to capture data; and
- Aggregate and analyse data (such as progress, RFI and outstanding issues) for project performance monitoring against the desirable outcomes.

The contractor should also appoint a competent digital lead to be responsible for setting up and operating CDE smoothly with proper infrastructure, technical team to support the CDE operations and business continuity plan, so that all data is well

¹ International best practices refer to ISO 19650 Organisation and digitalization of information about buildings and civil engineering works, including BIM - information management using BIM Part 1 to Part 5, and a National Annex of the ISO 19650 Part 2 Delivery phase of the assets.

protected and CDE usage by various stakeholders is not disrupted throughout the project lifecycle.

2.1.2 IDD Use Cases

The table below is a list of IDD use cases commonly adopted in local projects. The employer may select from the list or add new ones according to the project needs, to achieve the desirable project outcomes. For more information on these digital use cases, please refer to CDE Data Standard².

Table 2-1: Commonly adopted IDD Use Cases

S/N	IDD Uses	Definition
1	Digital Request for Information (RFI)	To use digital technology to request information or facilitate communication, in relation to any issue arising from the building works
2	Integrated concurrent Engineering (ICE)	To conduct an integrated concurrent engineering meeting in relation to the building works using digital technology and BIM
3	Visualisation and design checks	To utilise a BIM model, a digital three dimensional model or an immersive technology to visualise, seek feedback about and validate the design of the building;
4	Digital Submissions & Approval	To use digital technology to submit and obtain approval relating to the design of the building or any component involved in the building works
5	BIM-based documentation	To prepare documents relating to the building works based on information primarily generated from a BIM model
6	BIM-based cost estimation	To estimate costs at various stages of the building works based on information generated from a BIM model
7	Digital logistics	To use digital technology to plan the prefabrication production schedule of the building works, and digitally track and monitor the production, delivery and installation of prefabricated components
8	Digital construction scheduling & sequencing	To use digital scheduling to plan and monitor the construction activities of the building works
9	Digital progress & safety monitoring	To use digital solutions or digital scanning to track and manage progress of the building works, safety activities, observations and follow-ups.
10	Digital QA/QC inspections	To use digital solutions to record the observations from site inspections of the building works and track the necessary follow-up actions taken
11	Digital defects management	To use digital checklists or digital dashboards to manage and track the defects of the building works and the rectification of those defects

² Common Data Environment (CDE) Data Standard is a guideline that establish a standardized approach to managing, sharing, and exchanging project-related information within the construction industry. Please download the guide from <https://www1.bca.gov.sg/buildsg/digitalisation/integrated-digital-delivery-idd/idd-requirements>

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12	Digital handover	To use digital technology to generate and digitally hand over: (i) a digital model of a physical asset that is built as part of the building works; and (ii) any other documents relating to the physical asset, including but not limited to the following: a) the as-built records; b) the manufacturer's specifications and warranties; c) the operation and maintenance manuals
13	Real-time monitoring of assets performance	To set up a digital platform to monitor the real-time performance and track the key operating parameters of a physical asset that is built as part of the building works
14	Digital operations and maintenance	To set up a digital platform to integrate other technologies to perform the operations or maintenance of a physical asset that is built as part of the building works

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2.1.3 Enabling Technologies

The contractor should propose the list of digital technologies to support the adoption of IDD and include their proposal in IDD Implementation Plan (IDDIP) for employer's acceptance.

The contractor should set up the software and hardware for CDE and all IDD use cases within agreed timeframe after the IDDIP is approved. The contractor should organise necessary trainings to equip all project stakeholders, who may join at different stages of the project, with the skillsets to operate them. The contractor should also define the protocol for the project stakeholders to adhere to in operating the software and hardware. Special attention should be paid to data interoperability and analytics capabilities of the selected digital technologies.

The list of commonly used software and digital platforms are provided in Table 2-2 for reference. This list is not exhaustive and the inclusion in this list does not imply endorsement. Employers and contractors should explore additional software options and select software based to best suit their unique project needs.

Examples of Enabling Technologies (include but not limited to) refer to the latest list of commonly adopted solutions at <https://www1.bca.gov.sg/buildsg/digitalisation/integrated-digital-delivery-idd/idd-requirements/xxx>

(Example of the Enabling Technologies in the Table below will be listed on BCA webpage)

CDE	Most of the CDE platforms can support multiple IDD use cases. Examples of such Platform include Autodesk Construction Cloud, Bentley Projectwise, Leapthought Fulcrum, Oracle Aconex, CMS, Hubble, Novade.
BIM Authoring and Design Software	Software used to design and create 3D models and 2D drawings. Examples of such software include: <ul style="list-style-type: none"> • BIM Authoring - Autodesk Revit, Bentley OpenBuildings Designer, Graphisoft ARCHICAD, Tekla Structures. • M&E calculation/design – CHVAC, RHAC, Aurora, ETAP, Visual Lighting, DiaLux, AutoSPRINK • Structural analysis – Tekla Structural Designer, ETABS, STAAD Pro, Midas • Sustainability analysis – Autodesk Insight, Aconex, Open Studio, LCA
Other Enabling Technologies supporting various IDD use cases	Besides CDE platform and BIM software, there are other software supporting various IDD use cases. Examples of such software include: <ul style="list-style-type: none"> • Site set-out (BIM to field) – Leica, Trimble • Virtual mock-up, design review, fly through and mixed reality – Enscape, Fuzor, BIMx, BIMVision, VRCollab • Model coordination/Clash Detection – Navisworks, Solibri, iTwin • Quantity take-off and cost estimating – Assemble, CostX, Cubicost, Synchro, Navisworks • Scheduling – Fuzor, LeanPlanDo, Navisworks, Synchro

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	<ul style="list-style-type: none">• Product Lifecycle Management (PLM) and Logistic tracking with RFID/QR Code - Astoria, Sato Asia, CMS, Siemens Teamcentre• Issue tracking – BIMTrack, BIMCollab, Revizto• Reality capture – Leica, Trimble Geospatial• Photogrammetry - AirSquire, OpenSpace, Holobuilder• Computer Aid Facility Management (CAFM) - Gabkotech iREP FM, Chimeric Technologies Smart FM• Operation & maintenance platform - iTwin, Bentley AssetWise, Cornerstone Estate Management Lite, Schneider EcoStructure
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2.2 Roles and Responsibilities

The employer should clearly specify the roles and requirements of digital professionals in the contract. The employer can determine the list and quantity of professionals required based on the project needs. The typical roles and requirements of digital professional are provided in Table 2-3:

Table 2-3: Roles, Responsibilities, Competency and Experience of Digital Professional

Digital Professionals	Roles, Responsibilities, Competency and Experience
Digital Lead/ Manager	<p><u>Roles and Responsibilities</u></p> <ul style="list-style-type: none"> • Oversee implementation of IDD and development of IDD Implementation Plan (IDDIP); • Select appropriate digital technologies and integrate the processes across all phases of the project • Identify risks and migration measures associated with digital technologies and IDD processes; • Provide training and support to project stakeholders, including addressing issues, resolving conflicts and ensure successful implementation of IDD; • Track digital deliverables, report progress and IDD outcomes to employer. <p><u>Competency and Experience</u></p> <ul style="list-style-type: none"> • Digital Delivery Management Tier 2 Accredited³; OR • Min. 4 years of BIM or IDD management experience • Formally trained in BIM or IDD with a specialist diploma would be preferred.
Digital Specialist/ Coordinator	<p><u>Roles and Responsibilities</u></p> <ul style="list-style-type: none"> • Develop and implement IDDIP; • Ensures that the quality of information and models prepared adhere to the prescribed standards and protocol for sharing and coordination purposes; • Implement digital technologies to support IDD use cases; • Coordinate with project stakeholders to address issues and resolve conflicts; • Support Digital Lead/Manager to ensure all project digital deliverables and IDD outcomes are met. <p><u>Competency and Experience</u></p> <ul style="list-style-type: none"> • Digital Delivery Management Tier 3 Accredited; OR • Min. 2 years of work experience in BIM/ IDD projects • Formally trained in BIM or IDD with a diploma would be preferred.
Assistant Digital	<p><u>Roles and Responsibilities</u></p>

³ Digital Delivery Management (DDM) is the strategic approach to leverage digital technologies for efficient and effective project delivery. Please refer to the link for more information on DDM Accreditation.

<https://ddm.buildingsmartsingapore.org/ddm-accreditation-overview/>

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Specialist/ Modeller	<ul style="list-style-type: none"> • Prepare and update information deliverables including BIM models according to the prescribed standards; • Deliver information deliverables in a timely manner; • Report to Digital Specialist/Coordinator. <p><u>Competency and Experience</u></p> <ul style="list-style-type: none"> • Digital Delivery Management Tier 4 Accredited; OR • Min. 1 years of work experience in BIM/IDD projects • Formally trained in BIM or IDD with a diploma would be preferred.
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Apart from digital professionals, the employer should also require other key project stakeholders such as the designer, project manager, construction manager and site engineers / supervisors to possess the necessary proficiency to utilise digital solutions to execute their works, thereby contributing to the successful implementation of IDD.

2.3 IDD Deliverables

IDD Deliverables consist of the following key components:

- (i) IDD Implementation Plan (IDDIP) - a detailed plan outlining the systematic integration of digital tools and processes through the project lifecycle to meet the employer's IDD requirements;
- (ii) Project Information Model – a digital collection of necessary project information (including BIM Models, site management data, drawings, documents etc.) for fostering collaboration among project stakeholders, monitoring project progress and performance, and facilitating well-informed decision-making.

2.3.1 IDD Implementation Plan (IDDIP)

IDDIP covers information deliverables that extend beyond BIM Models, along with the corresponding processes and trainings. Within the IDDIP framework, the BIM Execution Plan (BEP), which primarily focuses on BIM deliverables, processes and use cases, is an integral component.

The IDDIP is a live document that should be continually updated throughout the project lifecycle. IDDIP shall include (without limitation) to the following:

1. Project's IDD objectives / desirable outcomes (with associated KPIs)
2. Responsibility Matrix⁴
3. Project Information Model (PIM) Delivery PlanBIM Execution Plan (BEP)
4. Risk Management Plan
5. Resource Plan

To allow employers to evaluate tenderers' digital competencies in implementing IDD before contract award, it is recommended for employers to request tenderers to submit either a preliminary Pre-Contract IDDIP or examples of IDDIP from previous

⁴ Responsibility Matrix defines which models and information are produced by whom, and the corresponding level of definition at different project stages.

projects as part of tender submission for assessment. Upon contract award, the appointed Digital Lead/ Manager of the successful tenderer should submit the detailed IDDIP for employer's approval. Once approved, the appointed Digital Lead/ Manager should communicate the IDDIP to all project stakeholders. The employer should also require the appointed Digital Lead/ Manager of the successful tenderer to review the DDIP regularly and update the IDDIP when required with the agreement of the employer and other key project stakeholders.

2.3.2 Project Information Model (PIM)

Project information model is the digital collection of necessary project information for fostering collaboration among project stakeholders, monitoring project progress and performance, and facilitating well-informed decision-making. It can include **BIM models, site management data**, drawings, documents etc.

2.3.2.1 BIM Models

The BIM Models are a set of digital representations of the physical buildings/structures to be constructed, created using a BIM authoring software. They should be shared through a Common Data Environment (CDE) with project stakeholders for further processing at specific project milestones according to specific naming, Quality Assurance (QA) / Quality Control (QC) and data exchange protocols outlined in the BIM Execution Plan.

The BIM Models should consist of a list of model elements and their parameters. The typical list of model elements and their parameters for different building typologies can be found in the Model Content Requirements (MCR)⁵ guide. Employers could take reference from the MCR guide when outlining their own model content requirements for the contractor to adhere to.

All design and construction BIM Models should be published in the CDE, and model authors are responsible for ensuring that BIM Models are consistently updated, coordinated, and readily shared with project stakeholders throughout the project lifecycle.

For projects with models developed for tender purposes, it is also recommended for employers to include the BIM model as part of the contract documents. This eliminates redundant efforts in recreating the models by tenderers / awarded contractors and enables them to utilise the BIM models for further development. More details can be found in the BIM Handover Technical Guide⁶.

⁵ The MCR is equivalent to the concept of level of information in the Exchange Information Requirements (EIR) delivered at different stages of project lifecycle. Please refer to <http://go.gov.sg/mcr> for more details on MCR.

⁶ The BIM Handover Technical Guide outlines a recommended list of essential BIM elements and attributes, specific model breakdown structure and formats to form the contract documents. Please refer to <http://go.gov.sg/bim-handover> for more details.

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2.3.2.2 Site Management Data

Beyond BIM, the Project Information Model should also consist of a list of site management data necessary for planning and tracking of project performance and site management, such as safety, time, cost, quality, productivity.

The employer should establish a set of such indicators, which serves as the minimum requirements, to be centrally and digitally monitored in line with the desirable project outcomes. Subsequently, the contractor should submit his proposal for the employer's review and approval. The contractor should be required to put in place a list of appropriate digital technologies to capture, store, manage, exchange, analyse and verify these data and report them to the employer at regular intervals throughout the project lifecycle. The site management data should also be exported and submitted to the employer in a format suitable for further processing when required.

A recommended list of Key Performance Indicators (KPIs) for site management data collection is found in Table 2-4 below. Employers may choose relevant KPIs from the below list or add new ones to form their requirements.

Table 2-4: Key Performance Indicators (KPIs) for Site Management Data Collection

KPIs to be used for IDD project performance management	
SAFETY Potential delay	<ol style="list-style-type: none"> 1. Accident Frequency Rate (AFR) 2. Accident Severity Rate (ASR) 3. Workplace Injury Rate (WIR) 4. No. of Safety non-Conformity 5. Accident / Incident Report
PRODUCTIVITY	<ol style="list-style-type: none"> 1. No. of Manpower (mandays) by Project 2. No. of Unique Count of Workers
QUALITY Building Quality	<ol style="list-style-type: none"> 1. Number & Types of Defects 2. Time Taken to Address Defects
TIME Progress Time, Predictability	<ol style="list-style-type: none"> 1. Time Taken to Resolve of Request for Information (RFI) 2. Time Taken to Approve Submissions 3. Extension of time 4. Schedule Variance between Actual and Plan Completion
COST Project Profitability & ROI	<ol style="list-style-type: none"> 1. Number of Variation Orders 2. Cost Variance between Actual and Budgeted Cost 3. Defects Rectification Cost 4. Operating Cost

Appendix A: Sample Clauses on Integrated Digital Delivery (IDD) Requirements

1. General
2. Common Data Environment (CDE), IDD Use Cases and Enabling Technologies
 - 2.1. CDE
 - 2.2. IDD Use Cases
 - 2.3. Enabling Technology
3. Roles and Responsibilities
 - 3.1. Roles and Responsibilities of Project Stakeholders
4. IDD Deliverables
 - 4.1. IDD Implementation Plan (IDDIP)
 - 4.2. Project Information Model

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1. General

- 1.1. This document outlines the Employer's requirements on Integrated Digital Delivery (IDD) for the project.
- 1.2. The Contractor shall ensure accuracy, consistency and timeliness in producing all IDD Deliverables. Any rectification due to lapses in this regard shall be the sole responsibility of the Contractor. All costs and expenses incurred to comply with the IDD requirements shall be deemed to be included in the Contract Sum.
- 1.3. The IDD Deliverables shall consist of various digital outputs including models, drawings, reports and data sets that represent project's the physical, functional and performance characteristics for the purpose of visualization, simulation, analysis, collaboration, planning, execution and documentation through the project lifecycle.
- 1.4. The Employer shall have the ownership and exclusive rights to all IDD Deliverables of the Project including IDD Implementation Plan (IDDIP) and Project Information Model (PIM) specified in Section 4. The Employer shall have the right to grant its appointed Consultant(s) the rights to use the IDD Deliverables for the purpose of the Project and subsequent operation and maintenance of the Works at his discretion. All the parties with access to the IDD Deliverables shall not use it other than for the purpose to deliver the projects without the Employer's prior approval.
- 1.5. The Contractor shall provide and maintain, at its own expense, the necessary hardware infrastructure to support the project. The Contractor shall obtain and maintain valid licenses for all necessary BIM/IDD software applications required for the project.
- 1.6. In this clause, key definitions relevant to the Integrated Digital Delivery (IDD) Requirements are provided below.
 - 1.6.1. **Asset Information Model (AIM)** means a sub-type of Project Information Model supporting the maintenance, management and operation of an asset throughout its lifecycle.
 - 1.6.2. **BIM Model** means a set of digital representations of the physical buildings/structures to be constructed, created using a BIM authoring software.
 - 1.6.3. **Common Data Environment (CDE)** means a centralised digital platform used for the collection, management & dissemination of project-related information.
 - 1.6.4. **Enabling Technologies** means a range of software applications and technologies utilised to support and enhance various aspects of project management and execution.
 - 1.6.5. **Federated Model** means a composite BIM Models that has been compiled by amalgamating several different models from various disciplines into one.

- 1.6.6. **Integrated Digital Delivery (IDD)** means the use of digital technologies to integrate work processes and connect stakeholders working on the same project throughout the project lifecycle. This includes design, fabrication, construction, as well as the operations and maintenance of buildings.
- 1.6.7. **IDD Implementation Plan (IDDIP)** means a detailed plan outlining the systematic integration of digital tools and processes through the project lifecycle to meet the employer's IDD requirements;
- 1.6.8. **IDD Use Cases** means a set of specific applications of digital technologies to integrate and optimise work processes and connect project stakeholders throughout the project lifecycle.
- 1.6.9. **Project Information Model (PIM)** means the digital collection of necessary project information for fostering collaboration among project stakeholders, monitoring project progress and performance, and facilitating well-informed decision-making. Project Information Model includes BIM Models, site management data, drawings, documents etc.

2. CDE, IDD Use Cases and Enabling Technologies

2.1. Common Data Environment (CDE)

(If the Employer provides CDE for supporting project collaboration, the Employer could indicate the use of such CDE by project stakeholders and omit this section from contract requirements)

- 2.1.1. The Contractor shall establish and maintain a Common Data Environment (CDE) to serve as the central repository for all Project Information Model for project collaboration throughout the project lifecycle. The CDE shall function as a single source of truth and ensures all project stakeholders have access to the most up-to-date and accurate information.
- 2.1.2. The Contractor shall obtain the approval of the Employer for the CDE deployed. The CDE shall be accessible by internet and be capable of handling commonly-used file types for BIM models, drawings and documents and data formats. It shall also be able to integrate data from all specified IDD use cases under the Contract.
- 2.1.3. The Contractor shall ensure that the CDE has the following features:
 - a) Capture, store, manage (including versioning), share, export, import and archive all project-related information;
 - b) Manage the access rights of the project stakeholders to specific information;
 - c) Set up workflows to manage quality and distribution of information;
 - d) Create digital forms to capture data; and
 - e) Aggregate and analyse data (such as progress, RFI and outstanding issues) for project performance monitoring against the desirable outcomes.
- 2.1.4. The Contractor shall operate CDE smoothly with proper infrastructure, technical team to support the CDE operations and business continuity plan.
- 2.1.5. The Contractor shall ensure project stakeholders, including but not limited to the Employer, design consultants, subcontractors, and any other project stakeholders deemed necessary by the Employer, has the appropriate access right to access content in the CDE at no additional cost.
- 2.1.6. The Contractor shall effectively manage Project Information Model within the CDE. The Contractor shall ensure that project stakeholders promptly update the Project Information Model so that any changes, revisions or new additions are accurately reflected and made available to relevant project stakeholders in a timely manner.
- 2.1.7. The Contractor shall offer technical support and training, as needed or directed by the Employer, to ensure that all project stakeholders can effectively utilise the CDE for project communication and information retrieval.
- 2.1.8. The Contractor shall implement data management measures and comply with relevant data protection and privacy practices in ensuring that the data stored in the CDE is adequately protected against unauthorised access, disclosure, or misuse.
- 2.1.9. The Contractor shall maintain robust backup measures for the CDE, adhering to data protection regulations for ensuring data integrity, availability, and timely recovery in case of loss or system failure, with regular reporting to project stakeholders.

2.2. IDD Use Cases and Data Deliverables

- 2.2.1. The Contractor shall utilize the enabling technologies submitted in IDDIP to facilitate implementation of IDD Use Cases throughout the project lifecycle.
- 2.2.2. The Contractor shall ensure the effective integration of data generated from IDD Use Cases into a CDE platform accessible to authorized stakeholders. The Contractor shall establish protocols for secure and organized access to relevant digital data and information.
- 2.2.3. The Contractor shall adhere to reporting schedules and standards submitted in IDDIP for delivering updates, progress reports, and other relevant documentation of IDD Use Cases through CDE. The Contractor shall maintain accurate and up-to-date digital records in compliance with industry standards and project requirements.
- 2.2.4. The Contractor shall ensure the accuracy, completeness, and integrity of data generated or managed through digital tools used for IDD Use Cases. The Contractor shall promptly rectify any identified discrepancies or errors in digital data and documentation.
- 2.2.5. The Contractor shall actively engage in collaborative efforts facilitated by CDE platforms to coordinate with project stakeholders for IDD Use Cases implementation. The Contractor shall participate in digital communication channels and meetings as required for effective stakeholder engagement.
- 2.2.6. The contractor shall provide necessary training and support to relevant project enabling technologies tools and processes for IDD Use Cases. The Contractor shall conduct knowledge transfer sessions to enable stakeholders to independently manage digital workflows post-project completion.
- 2.2.7. The Contractor shall implement a list of IDD use cases, as specified in Table A2-1.
- 2.2.8. The Contractor shall submit a timeline to the Employer for implementing the list of digital technology and produce the list of deliverables of the use cases in the IDDIP.

Table A2-1: IDD Use Case and Deliverables

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(The Employer to choose relevant IDD Use Cases from the below list or add new ones to form the requirements.)

S/N	IDD Use Cases	Definitions	Data Deliverables
1	Digital Request for Information (RFI)	To use digital technology to request information or facilitate communication, in relation to any issue arising from the building works	List of issues raised and resolved
2	Integrated concurrent Engineering (ICE)	To conduct an integrated concurrent engineering meeting in relation to the building works using digital technology and BIM	Digital records of decisions, actions to be taken and party responsible
3	Visualisation and Design Checks	To utilise a BIM model, a digital 3 dimensional model or an immersive technology to visualise, seek feedback about and validate the design of the building	Digital 3D Models or rendered models
4	Digital Submissions & Approval	To use digital technology to submit and obtain approval relating to the design of the building or any component involved in the building works	Digital data required for approval site verification report
5	BIM-Based Documentation	To prepare documents relating to the building works based on information primarily generated from a BIM model	BIM Models, drawings, schedules etc
6	BIM-Based Cost Estimation	To estimate costs at various stages of the building works based on information generated from a BIM model	Quantity and costing models
7	Digital Logistics	To use digital technology to plan the prefabrication production schedule of the building works, and digitally track and monitor the production, delivery and installation of prefabricated components	Production and delivery schedules and status Digital logistic delivery records
8	Digital Construction Scheduling & Sequencing	To use digital scheduling to plan and monitor the construction activities of the building works	Time-based construction schedules, simulations or sequencing models
9	Digital Progress & Safety Monitoring	To use digital solutions or digital scanning to track and manage progress of the building works, safety activities, observations and follow-ups.	Records of progress photos, updates to schedules and 3D models and progress reports
10	Digital QA/QC Inspections	To use digital solutions to record the observations from site inspections of the building works and track the necessary follow-up actions taken	Records of QA/QC inspections; Audit trails of resolution

11	Digital Defects management	To use digital checklists or digital dashboards to manage and track the defects of the building works and the rectification of those defects	Digital defect records by location; Defects rectification reports
12	Digital Handover	To use digital technology to generate and digitally hand over: <ul style="list-style-type: none"> (i) a digital model of a physical asset that is built as part of the building works; and (ii) any other documents relating to the physical asset, including but not limited to the following: <ul style="list-style-type: none"> a) the as-built records; b) the manufacturer's specifications and warranties; c) the operation and maintenance manuals. 	AIM (geometry and non-geometry), building systems documentation, operation and maintenance manuals, warranty
13	Real-time Monitoring of Assets Performance	To set up a digital platform to monitor the real-time performance and track the key operating parameters of a physical asset that is built as part of the building works	Building performance data; Energy consumption records
14	Digital Operations and Maintenance	To set up a digital platform to integrate other technologies to perform the operations or maintenance of a physical asset that is built as part of the building works	Work orders for operations & maintenance; Records of faults and resolutions

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2.3. Enabling Technologies

- 2.3.1. The Contractor shall propose the necessary digital technology (both hardware and software) to support the implementation of the IDD and include their proposal in the IDDIP for Employer's approval.
- 2.3.2. The Contractor shall set up the software and hardware for CDE and all IDD use cases within _____ days of the approval of the IDDIP, and be responsible in ensuring data interoperability and analytics capabilities of the selected digital technologies.
- 2.3.3. The Contractor shall organise necessary trainings to equip all project stakeholders, who may join at different stages of the project, with the skillsets to utilise the proposed digital technologies. The Contractor shall also define the protocol for the project stakeholders to adhere to in operating the software and hardware and such protocols should be documented on the CDE for easy access by all project stakeholders.
- 2.3.4. The Contractor shall provide the approved digital technology with proper licensing for project stakeholders' utilisation. The licensing shall cover technical support guaranteeing the usability of the digital technology throughout the Contract. Any issues reported shall be addressed within _____ days from the notification date.
- 2.3.5. The Contractor shall extend technical support for all digital technology guaranteeing its usability throughout the Contract. Any issues reported shall be addressed within _____ days from the notification date.
- 2.3.6. The Contractor shall provide IDD training illustrating project goals and effective collaboration. The Contractor shall customize the training programs for digital onboarding for effective use of IDD Deliverables throughout the project.

3. Roles and Responsibilities

3.1. Roles and Responsibilities, Competency and Experience of IDD Personnel

3.1.1. The Contractor shall assign a team of IDD personnel to carry out IDD implementation. The required digital professionals, their roles and responsibilities, and competency requirements are listed in Table A3-1 below:

Table A3-1: Roles, Responsibilities, Competency and Experience of BIM and IDD Personnel

(The Employer to determine the list and quantity of professionals required based on the project needs)

Digital Professionals Roles & Responsibilities	Competency and Experience
<p>_____ Nos of Digital Lead/ Manager</p> <ul style="list-style-type: none"> • Oversee implementation of IDD and development of IDD Implementation Plan (IDDIP); • Select appropriate digital technologies and integrate the processes across all phases of the project • Identify risks e.g. interoperability challenges, skills gaps, and migration measures associated with digital technologies and IDD processes; • Provide training and support to project stakeholders, including addressing issues, resolving conflicts and ensure successful implementation of IDD; • Track digital deliverables, report progress and IDD outcomes to employer. 	<ul style="list-style-type: none"> • Digital Delivery Management Tier 2 Accredited; OR • Min. 4 years of BIM or IDD management experience • Formally trained in BIM or IDD with a specialist diploma would be preferred.
<p>_____ Nos of Digital Specialist/ Coordinator</p> <ul style="list-style-type: none"> • Develop and implement IDDIP; • Ensures that the quality of information and models prepared adhere to the prescribed standards and protocol for sharing and coordination purposes; • Implement digital technologies to support IDD use cases; • Coordinate with project stakeholders to address issues and resolve conflicts; • Support Digital Lead/Manager to ensure all project digital deliverables and IDD outcomes are met. 	<ul style="list-style-type: none"> • Digital Delivery Management Tier 3 Accredited; OR • Min. 2 years of work experience in BIM/ IDD projects • Formally trained in BIM or IDD with a diploma would be preferred.
<p>_____ Nos of Associate Digital Specialist/ Modeller</p> <ul style="list-style-type: none"> • Prepare and update information deliverables including BIM models according to the prescribed standards; • Deliver information deliverables in a timely manner. • Report to Digital Specialist/Coordinator 	<ul style="list-style-type: none"> • Digital Delivery Management Tier 4 Accredited; OR • Min. 1 years of work experience in BIM/IDD projects • Formally trained in BIM or IDD with a diploma would be preferred.

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4. IDD Deliverables

The Contractor shall prepare and submit the IDD Implementation Plan (IDDIP) and Project Information Model (PIM) as part of IDD deliverables. The Contractor shall collaborate with all relevant project stakeholders in the development and refinement of the IDDIP and PIM. The ownership of all the IDD deliverables shall belong to the Employer.

4.1. IDD Implementation Plan (IDDIP)

- 4.1.1. The Contractor shall submit a detailed IDD Implementation Plan (IDDIP) within in ____ month(s) from Contract award for Employer's approval. The Plan shall outline the Contractor's approach to meet the Employer's IDD requirements.
- 4.1.2. Prior to submitting the IDDIP to the Employer for approval, the Contractor shall discuss the IDDIP with relevant project stakeholders as determined by the Employer to obtain their consensus. Upon approval of the IDDIP, the Contractor shall communicate the approved IDDIP to all project stakeholders.
- 4.1.3. The IDDIP shall cover information deliverables that extend beyond BIM Models, along with the corresponding processes and trainings. The IDDIP is a living document and the Contractor's Digital Lead shall update the IDDIP periodically throughout the Contract period. Any modifications to the approved IDDIP shall be discussed with the relevant project stakeholders and approved by the Employer.
- 4.1.4. Where there is a preliminary IDDIP submitted by the Contractor as part of the Tender Offer, the IDDIP shall not contradict the said preliminary IDDIP without the Employer's approval.
- 4.1.5. The Contractor shall develop and deliver IDDIP detailing the strategy, processes, and key milestones for information deliverables throughout the project life cycle. The IDDIP shall encompass the following components:
 - a) **IDD Objectives / Desirable Outcomes** - The Contractor shall outline the objectives related to digital technology for project activities to meet the desirable project outcomes. The Contractor shall list out the anticipated measurable improvements for the overall project outcomes.
 - b) **Responsibility Matrix** - The Contractor shall create a Responsibility Matrix, specifying the list of personnel involved in the project, and their roles and responsibilities in IDD implementation, and training plans for all project stakeholders involved in IDD implementation.
 - c) **PIM Delivery Plan** – The Contractor shall provide a plan for managing the delivery of PIM throughout the project lifecycle. The Contractor shall consolidate individual task information delivery plans and detail the sequence and delivery schedules of PIM.

- d) BIM Execution Plan (BEP) - The Contractor shall develop a BEP as part of the IDDIP, detailing the methodology for deploying BIM workflows, uses, tools, and techniques to generate, share, and publish BIM deliverables.
- e) Risk Management Plan – The Contractor shall identify potential risks related to the management and production of PIM throughout the project lifecycle. The Contractor shall propose strategies and measures for risk mitigation.
- f) Resource Plan - The Contractor shall create a plan showing the adequacy of resources, processes, and technologies required for IDD use cases. The Contractor shall test, document and validate the procedure and technology.

4.2. Project Information Model

4.2.1. BIM Models

- 4.2.1.1. The Contractor shall produce and submit the Project Information Model which describes the physical, functional, and performance attributes of the project to both the Employer and the Consultant at each project milestone, as indicated in the IDDIP.
- 4.2.1.2. If the Employer issued the BIM Models in native format and 2D drawings as contract document, the Contractor shall highlight discrepancies between BIM Models or between BIM Models and drawings to the Employer. The Employer has the sole discretion to determine the resolution of discrepancy, and no claims for cost and time shall be entertained where the Contractor's resolution of the discrepancy is to comply with any of the Contract Requirements.
- 4.2.1.3. During the course of work, the Contractor shall further develop the BIM Models and ensure they are well coordinated and updated to remain as the single source of truth throughout the contract period. The Contractor shall use the outputs from BIM Models for drawing production, visualisation, construction sequencing simulation, cost estimation, collaboration, planning and documentation throughout the project life cycle.
- 4.2.1.4. The Contractor shall ensure that the elements and parameters of BIM Models are created in alignment with the relevant Model Content Requirements (MCR) and the prevailing version of the CORENET X Code of Practice (CoP) at distinct project stages before submissions. The Contractor shall share the updated BIM Models with the consultants for updating of consultants' design models.
- 4.2.1.5. Whenever feasible, the Contractor shall derive and generate drawings from the BIM Models. The scope of drawings includes plans, sections, elevations, and schedules.
- 4.2.1.6. The Contractor shall publish and share all the BIM Models through CDE with project stakeholders for processing at specific project milestones according to specific naming, Quality Assurance (QA) / Quality Control (QC) and data exchange protocols outlined in the IDDIP. The Contractor shall ensure that BIM Models are consistently updated, coordinated, and readily shared with project stakeholders throughout the project lifecycle.

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- 4.2.1.7. The Contractor shall submit the Asset Information Model (AIM) to the Employer before project completion. Information contained in the AIM should include information in _____(e.g. Unifomat/OminiClass/Uniclass) format to facilitate data extraction for the purpose of operations and maintenance.
- 4.2.1.8. Upon project completion or termination, the Contractor shall handover the Project Information Model to the Employer or their designated representative in the format required.
- 4.2.1.9. The Contractor shall submit all BIM deliverables in accordance with the table below to the Employer at each project milestone. The submission dates for BIM deliverables shall be recorded in the IDDIP.

Table A4-1: BIM Uses and Data Deliverables
(The Employer to adjust the following table according to the BIM uses selected)

S/N	BIM	Data Deliverables
1	Design Model <i>(for Design & Build Contract only)</i>	Site models with coordinates, massing models, architectural models, structural models, MEP models, and Federated Model
2	Detailed Design Model <i>(for Design & Build Contract only)</i>	More detailed version of Architectural models, structural models and calculation, MEP models & analysis and Federated Model with accurate dimensions, shape, location, orientation and quantity. Clash detection report.
3	Quantity and Costing Models	BIM Models for detailed quantity, cost estimate and bills of quantity, with reference to the SISV Quantity Surveying BIM Attribute Requirements (QSBAR).
4	Construction Model	BIM Models with complete fabrication and assembly details and key services coordinated for exporting construction drawings, shopdrawings and services drawings; Safety model
5	Scheduling Model	BIM Model for simulation of construction sequence
6	As-Built Model	As-built models for each discipline and Federated Model updated with changes during construction stage
7	Asset Information Model	BIM Model as a representation of the actual completed buildings for space management, building maintenance and modifications made during occupancy

4.2.1.10. The Contractor shall use his best efforts to define standards and adhere to good practices outlined in Table A4-2 below with reference to the Singapore BIM Guide Version 2, Singapore VDC Guide, Model Content Requirements (MCR) and Singapore National Annex of ISO 19650-2.

Table A4-2: Modelling Procedure

S/N	Category	Modelling Procedure
1	Standard	<ul style="list-style-type: none"> • Make reference to MCR and determine appropriate BIM elements and attributes naming convention • Determine MEP System colour convention
2	Authoring Software and File Format	<ul style="list-style-type: none"> • Determine BIM authoring software and version • Determine file formats for model sharing • Determine file naming convention
3	Control Elements	<ul style="list-style-type: none"> • Set origin points geo-referenced to the Singapore SVY 21 coordinate system (x, y) and to the Singapore Height Datum for Height (z) • Orient site model in True North or real-world orientation • Align grids across all models • Set building levels
4	Model Content	<ul style="list-style-type: none"> • Model required BIM elements and attributes correctly • Provide 2D details, schedules, views and sheets • Adopt appropriate BIM category/ elements • Adopt appropriate BIM elements level of details • Create BIM elements according to levels e.g. break columns by level instead of going through multiple levels • Remove unintended elements, 2D objects, sheets, views, legends, links and schedules • Optimize individual file size to be less than 200MB
5	Intra-discipline Coordination	<ul style="list-style-type: none"> • Eliminate duplicated BIM elements • Eliminate overlapped BIM elements
6	Inter-discipline Coordination	<ul style="list-style-type: none"> • Resolve significant clash and clearance issue • Ensure consistency and alignment between trades • Highlight the model elements relevant to > 1 discipline and assign the responsible project stakeholders • Arrange ICE session to address inter-discipline issues

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4.2.2. Site Management Data

4.2.2.1. The Contractor shall establish suitable digital technologies to capture, store, manage, exchange, analyse site management data and report the following KPIs found in Table A4-3 for planning and tracking of project performance and site management.

Table A4-3: Key Performance Indicators (KPIs) for IDD Project Performance Management
(The Employer to choose relevant IDD performance indicators from the below list or add new ones to form the requirements)

KPIs to be used for IDD project performance management	
SAFETY Potential delay	<ol style="list-style-type: none"> 1. Accident Frequency Rate (AFR) 2. Accident Severity Rate (ASR) 3. Workplace Injury Rate (WIR) 4. No. of Safety non-Conformity 5. Accident / Incident Report
PRODUCTIVITY	<ol style="list-style-type: none"> 1. No. of Manpower (mandays) by Project 2. No. of Unique Count of Workers
QUALITY Building Quality	<ol style="list-style-type: none"> 1. Number & Types of Defects 2. Time Taken to Address Defects
TIME Progress Time, Predictability	<ol style="list-style-type: none"> 1. Time Taken to Resolve of Request for Information (RFI) 2. Time Taken to Approve Submissions 3. Extension of time 4. Schedule Variance between Actual and Plan Completion
COST Project Profitability & ROI	<ol style="list-style-type: none"> 1. Number of Variation Orders 2. Cost Variance between Actual and Budgeted Cost 3. Defects Rectification Cost 4. Operating Cost

4.2.2.2. The Contractor shall ensure that digital tools used for KPI tracking are capable of integrating data from various sources, providing a comprehensive and accurate representation of project performance.

4.2.2.3. The Contractor shall grant Employer and parties appointed by the Employer access to the digital tools and platforms used for tracking KPIs, ensuring transparency and the ability to independently verify reported performance metrics.

4.2.2.4. The Contractor shall harness data generated from digital tools and report KPIs at an interval approved by the Employer. The Contractor shall configure digital dashboards that present KPIs in a clear and easily understandable format. The dashboards shall be customizable to accommodate specific stakeholder preferences and requirements.

Appendix B: Sample Clauses to be incorporated in the Instructions to Tenderers

- 1.1 Tenderers shall submit a **preliminary** IDD Implementation Plan (IDDIP) to demonstrate how all **IDD deliverables** can be achieved with the necessary **technical and manpower resources** as part of the Tender Proposal
- 1.2 As a minimum requirement, the **preliminary** IDDIP shall include the following:
 - a) Tenderer's IDD Goals: a set of project delivery goals (with measurable performance indicators) that can be achieved in IDD implementation;
 - b) Tenderer's proposed technical resources (which include Common Data Environment (CDE), software and hardware) for IDD implementation;
 - c) Tenderer's proposed digital manpower resources (please indicate if the manpower resources are outsourced) for IDD implementation, and their roles and responsibilities;
 - d) Tenderer's proposed value chain partners on board the IDD ecosystem;
 - e) Tenderer's proposed approach to achieve the IDD deliverables;
 - f) Tenderer's past track records in IDD implementation in projects of similar scale and complexity, if any.

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