

Annexure 6.5

[Section 6: Scope of Work]

Employer's Information Requirement (EIR)

BUILDING INFORMATION MODELLING

Bid No. DK/GC/COR-OF/026, Engagement of General Consultant for Delhi–Panipat–Karnal Namo Bharat Corridor.



NCRTC- EMPLOYER'S INFORMATION REQUIREMENTS (EIR)

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1. Purpose of Document

National Capital Region Transport Corporation (NCRTC) hereafter also referred as ‘**Client**’ or ‘**Owner**’ or ‘**Employer**’ require all project stakeholders (General Consultant, Detailed Design Consultants/ Contractors or commonly called as ‘**Suppliers**’) to work on BIM (Building Information Modelling) during design, construction, handover and operations stage. This document outlines the Employer’s Information Requirements (EIRs) for the BIM application.

1.1. BIM Goals/ Objectives

NCRTC has set major **BIM Goals and Objectives** that are provided in the [Table 1](#).

Table 1-NCRTC’s BIM Goal and Objectives

S. No.	Goal Description	Potential BIM Use
1	Provision of standardized 3D digital construction document models which facilitate audit, analysis, construction and renovation.	Design Authoring
2	Improved visualization and presentation of virtual designs to validate design goals such as aesthetics, layout, sightlines, safety, passenger flow, security, etc.	Design Reviews
3	Reduce and eliminate building system construction errors by digital modelling of building system geometries to detect conflicts or clashes.	3D Coordination
4	Precise quantity take-off and estimate of asset costs and alternative schemes during the project life-cycle.	Quantity surveying and cost-estimation
5	Better tracking of construction on site and ensuring the project stays on time	L3 (Schedule)
6	Accurate documentation of building/asset systems geometry and data to facilitate and automate O&M operations.	Record Modelling
7	Automated access to building asset information by linking the record information model to the owner’s computerized maintenance management system (CMMS). This would include linked access to building system operation routines, maintenance manuals, equipment specifications and fabrication documents.	Asset Management
8	Increased efficiency in building maintenance by use of information model data links to the Owner’s computerized maintenance management system (CMMS).	Building Maintenance Scheduling
9	Provide evidence of a proper interface management extracting CSD (Combined Service Drawings), SEM (Structural, Electrical, Mechanical) drawings, and providing evidence of Maintenance and Equipment Routing accessibility	Interface/integration Management

The aim of this document is to provide a definition of Employer’s Information Requirements (EIRs)¹ to support the implementation of Building Information Modelling (BIM) on Delhi-Karnal Namo Bharat Corridor.

¹ EIR is a pre-tender document, setting out the information to be delivered, and the standards and processes to be adopted by the supplier (general consultant, design consultants and contractors) as part of the project delivery process and is complemented by a BIM Execution Plan.

No part of this document should be considered as preventing the Consultants, Specialist subcontractors and Specialist suppliers from sharing their respective models at any time and in any format, if this is to be helpful to project progress and co-ordination.

2. Applicable Standards

To establish a consistent approach to collaboration and delivery of information, NCRTC requires the project consultants and their associated supply chain to adopt the following standards:

- NCRTC’s BIM Standards (*To be provided after award of contract*)
- Uniclass 2015 (NBS Toolkit) classification system- The Detailed Design Consultant (DDC) is required to classify elements/ objects within the Building Information Models using Uniclass2015 classification system.
- LOD² (Level of Definition) – its interpretation and meaning are in accordance with the NBS Toolkit LOD Specification that incorporates standard definitions from PAS 1192/ISO19650
- COBie UK-2012

3. Technical

This section establishes technical information requirements, including software, stage-wise BIM Uses and deliverables, responsible party for respective BIM uses and Level of Definition.

3.1. BIM Uses

Table 2: BIM Uses lists the stage-wise BIM Uses which NCRTC is targeting. These uses are being designated as ‘**mandatory**’, which implies that the Employer intends to mandate its usage.

² ‘**LOD**’ is defined as **Level of Definition** as per UK’s PAS 1192-2:2-13 and has two components to it, one ‘**Level of model detail**’ (geometric detail) and ‘**level of model information**’ (non-geometric detail). Level of model detail is also abbreviated as ‘**LOD**’, whereas level of model information is abbreviated as ‘**LOI**’.

Table 2: BIM Uses

BIM Use	Responsible Party	Exchange Format
Preliminary Design Stage (PD)		
Authoring of Building Information Models as per Section 8 of ‘Scope of work’ for e.g.: <ul style="list-style-type: none"> • Architecture discipline • Structure (excluding rebar) discipline • Services (mechanical, electrical, plumbing, fire-fighting etc.) and production of drawings 	GC/DDC/ Contractor *	Models in the following format- <ul style="list-style-type: none"> • Native file format • IFC4 Add2 • NWC/ NWD 2D drawings as produced from the model to be in DWG & PDF format
Clash Detection/ Design & Services Coordination	GC/DDC/ Contractor *	BCF, Clash Log (XLS)
Quantity take-off & Cost-Estimation	GC/DDC/ Contractor *	XLS
Preparation of Computer simulated passenger flow models using design BIM models	GC/DDC/ Contractor *	Video animation format (AVI, MPEG or equivalent), report in PDF, DOC format
BIM based Energy Analysis (Energy, façade, Lighting levels & Daylighting Analysis)	GC/DDC/ Contractor *	PDF, DOC (report) or as defined in Scope of Workdocument for appointment of DDC
Definitive Design Stage (DD)		
Authoring of Building Information Models as per Section 8 of ‘Scope of work’ for e.g.: <ul style="list-style-type: none"> • Architecture discipline • Structure (excluding rebar) discipline • Services (mechanical, electrical, plumbing, fire-fighting etc.) And production of drawings 	DDC/ Contractor *	Same as defined in ‘PD Stage’
Clash Detection/ Design & Services Coordination	DDC/ Contractor *	Same as defined in ‘PD Stage’
Quantity take-off & Cost-estimation	DDC/ Contractor *	Same as defined in ‘PD Stage’
4D simulation of construction sequencing (as applicable for respective DDC packages) and 4D Simulation of traffic diversion plans (upto L3 schedule)	DDC/ Contractor *	Video animation format (AVI, MPEG or equivalent)

Rebar model development + drawing production	DDC/ Contractor *	2D drawings as produced from the model to be in DWG &PDF format.
Good for Construction (GFC) Stage		
Pre-Construction Stage - Design Documents <i>(Production of Construction Reference Drawings, Good for Construction Drawings and Details/ shop drawings)</i>		
All discipline model updating and drawing production	DDC/ Contractor *	Same as defined in 'PD Stage'
Pre-Construction Stage – Planning Documents		
Using 4D-BIM for validation and visualization of as-planned construction (time) Schedule	Contractor	Video animation format (AVI, MPEG or equivalent)
Construction Stage (CA)		
Using 4D-BIM for Construction Progress Tracking i.e. Comparison of as-planned and in-progress construction schedule (upto L3 schedule)	Contractor	Video animation format (AVI, MPEG or equivalent),Report of the differences (PDF, Word)
Using 5D-BIM for validation of planned v/s actual construction cost	Contractor	Report of the differences (PDF, Word, excel) Comparison of as-planned and in- progress construction cost (pdf/contractual planning SW)
As-built model preparation and production of as-built drawings	Contractor	Models in the following format- <ul style="list-style-type: none"> • Native file format • IFC4 Add2
Project Handover Stage (PH) Record Modelling (compiling of facility management"7D" and asset management related information within the final As-built model)	GC/ Contractor & DDC³	Models in the following format- <ul style="list-style-type: none"> • Native file format • IFC4 Add2 Non-graphical data in COBie v2.4 format (Excel)

³ Contractor to populate As-built BIM models with equipment information related to Facility Management/Asset Management, available during the construction stage and hand-it-over to GC.

Notes-

- * ‘DDC/GC’ to be responsible for the activity in case of item rate contracts and Contractor’s DDC in case of “Design & Build Contracts” and Contractor
- NCRTC is in process of finalizing software/s applications for internal use for BIM based quantity extraction, cost-estimation, 4D & 5D BIM, Facility and Asset management works. In case any deliverable is needed in the format not specified above, then that shall be specified at a later stage and the consultant is required to provide the same to NCRTC unless technically not possible. Any cost incurred in purchase of any plug-in or application to perform this task, shall be borne by the consultant. *However, NCRTC believes in the philosophy of OpenBIM and while selecting any software application, priority shall be given to the software application which is vendor neutral.*

3.2. Software platforms

The following software applications will be used by NCRTC. The input format for these software applications has also been listed here. The design consultants and contractors need to ensure that their respective software application/s can deliver output in the format as described in Table 3.

Table 3: Software and Input file format for Model Auditing/ Clash-detection

BIM Uses	Software Name	Input file format
Model Auditing/ Clash-detection	Solibri Model Checker (v9.8)	IFC4 Add2 BCF ⁴ files (<i>for tracking issues</i>)
	Navisworks Manage 2024	NWC/NWD BCF files (<i>for tracking issues</i>)
Design Authoring	AUTODESK CIVIL3D 2024 AUTODESK REVIT 2024 AUTODESK DYNAMO	(.rvt, .ifc.pdf) (.landXML, .dwg, .pdf)
4D/ 5D Planning	MICROSOFT PROJECT, SYNCHRO or BEXEL	(.mpp, .xls, .wmv, .mp4)

NCRTC also plans to implement a tool for ‘**Common Data Environment**’ for project collaboration and document management.

For design authoring BIM tools, NCRTC would prefer Revit, Civil 3D (2024) or equivalent software application/s to be used by the consultants. Any update or change in software versions undertaken by the supplier during the project, needs to be approved by NCRTC. At the same time NCRTC may request software version to be updated at any point during the project. This transition can happen within a mutually agreed timeframe.

3.3. Data Exchange Protocols & Asset Information Model (AIM)

It is a key requirement of NCRTC that asset information developed in the design and construction phases of the project can be incorporated into a Computer-Aided Facilities Management (CAFM) system. Hence the use and responsibility, format and frequency of shared information, should be understood by all project team members.

⁴ BCF stands for ‘BIM Collaboration Format’. Details can be referred from- <http://www.buildingsmart-tech.org/specifications/bcf-releases>

To support the development of an AIM, it is mandatory that for each data exchange (i.e. at completion of each stage or as and when requested by **NCRTC**) and at handover, the following information will be provided from the same dataset:

- Design Building Information Models in native file format
- Drawings extracted from BIM models in CAD and pdf format
- COBie-UK-2012 export v2.4
- 3D Industry Foundation Classes (IFC4 Add2⁵)

Any inconsistencies in data are to be addressed by the originating consultant or contractor. Responsibilities for providing this information are to be recorded in the Building Information Modelling Execution Plan (BEP).

For clarity and consistency, Industry Foundation Classes (IFC) export settings are to be recorded in the project BIM Execution Plan and must be consistent throughout the project.

3.3.1 Asset Information Model (As-Built BIM Model)

As defined in the project Asset Information Requirements (AIR), the AIM will be a digital representation of the Built Asset in its physical and geometrical definition, as well as a digital repository for all non-graphic information related to all the elements that are integrated within the Built Asset.

The AIM will represent the As-Built state of the asset at the time of handover, in order to achieve this, all stakeholders involved will have to collaborate in response to the specified requirements.

The responsible party for each BIM deliverable and at which phase is required is identified in Table 2 – BIM Uses, in order to clarify this information, NCRTC defines the overall responsibilities and actions required for each stakeholder through the different project phases:

- **Preliminary to Pre-Construction Phases** – During all design phases the Designer (GC/Contractor as per their defined scope of work in relevant chapters) will be responsible for the development of all BIM models and the production of all the project related information, it's responsibilities will be but not limited to:
 - Developing the different specialist design models according to the LOD/LOI Matrix and information. Defining the Asset Geometrical configuration to communicate design intention and assure constructability.
 - Populating the BIM models with all design relevant information, including element classification according to this EIR.
 - Drawing production through extraction from the BIM Model.
 - Creating all parametrization required by NCRTC to comply with the AIR for Asset Management. These parameters will be populated by the Contractor during construction.
- **Construction Phase** – During the construction phase the contractor will be the responsible to update all BIM models with all the modifications implemented during construction which will be reviewed by GC, it's responsibilities will be but not limited to:
 - Updating the geometrical information for the Asset accordingly to modification made to the project. These modifications, if considered major alterations to the design intent by NCRTC, might need the approval from the Designer.

- For changes initiated by NCRTC, the DDC will update the BIM model and for changes initiated/proposed by the contractor the BIM model will be updated by the contractor, including resolution of all clashes with other disciplines.
- Contractor will be responsible to manage the interface between all disciplines that are, directly or indirectly, affected by any changes made during the construction phase. And updating all specialist BIM Models that require changes.
- Updating any information provided by the designer within the BIM Model that have undergone modifications during construction.
- Updating all drawings accordingly to the modifications implemented during construction. To ensure all drawings are developed and extracted from the BIM Model, it will be essential to keep both the Specialist models, and the Documentation Extraction models updated during the construction.
- Populating the BIM Model with the information required by NCRTC for Asset Management through the parameters previously created by the DDC.
- **Handover** – At handover the AIM will have to be revised by the contractor to ensure that it complies with the AIR and that all the information modified and generated during construction is updated in the model. Any inconsistencies in data are to be addressed by the originating consultant or contractor. Responsibilities for providing this information are to be recorded in the Building Information Modelling Execution Plan (BEP).

To support the development of an AIM, it is mandatory that for each data exchange (i.e. at completion of each stage or as and when requested by **NCRTC**) and at handover, the following information will be provided from the same dataset:

- Design Building Information Models in native file format
- Drawings extracted from BIM models in CAD and pdf format
- COBie-UK-2012 export v2.4
- 3D Industry Foundation Classes (IFC2X3 or IFC4 Add2⁵)

For clarity and consistency, Industry Foundation Classes (IFC) export settings are to be recorded in the project BIM Execution Plan and must be consistent throughout the project.

3.4. Asset Information Requirements (AIR)

At handover, NCRTC requires asset information to be delivered as part of the information model. As per BS 1192-4:2014, Fulfilling employer's information exchange requirements using COBie- Code of Practice, the integrity of data included within the COBie schema, should be ensured as follows-

- Every hosted component should be assigned to at-least one Space.
- Every hosted component should be assigned to one Type.
- Every hosted component should be assigned to at least one System.
- Every Space should be assigned to at least one Zone.
- Every reference to other sheet should be valid.
- Every reference to Pick List enumerations and classifications should be valid.

- Enumerations specified in the Attributes and Pick Lists should be adhered to.

To ensure consistency, all COBie deliverables should have continuity with earlier deliverables and shall be developed cumulatively to enable comparison and validation. Deliverables should re-use the unique asset names defined in earlier deliverables and external identifiers, such as Global Unique Identifiers (GUIDs) are to be maintained.

All NCRTC required equipment shall include the following attributes-

- Equipment GUID
- Asset Identification Number (Nomenclature system for this shall be shared with the Consultant post award of contract)

Currently NCRTC is in process of identifying and listing down the assets which will be important from operations and maintenance perspective, plus, the **information parameters (object property sets)** which needs to be attached with respective model elements to populate them with facility and asset management related information as and when it is available in project life-cycle.

Once this information is prepared by **NCRTC**, the same shall be shared with the GC/Contractor. GC/Contractor is required to attach the information parameters (object property sets) to respective BIM elements. This is to be undertaken irrespective of the data for that parameter field is required/available at that stage or not. This is to enable data to be included at stages later in the project life-cycle.

⁵ IFC4 Add2 – Details can be referred from '<http://www.buildingsmart-tech.org/specifications/ifc-releases/ifc4-add2>'

3.5. System Performance

To support access and use of information for all parties, the following guidelines must be met-

- Federated models when shared should not exceed 500MB.
- To improve performance, files must be optimized to reduce unnecessary memory usage.

It is further suggested that, wherever possible individual models should not exceed 150MB. Suppliers unable to process a file of this size should seek to address this immediately and inform the Employer.

3.6. Coordinates

BIM models of via-duct and tunnels will be required to be divided into sections/ parts/ volumes keeping in mind the workability and system performance criteria as defined in [Section 3.5 System Performance](#). All the individual model files shall be geo-referenced to enable integration with GISbased applications and when a federated BIM model of any section of Delhi-Karnal corridor is prepared it should get properly aligned. **All the components shall be geo-referenced to main control point, the co-ordinates for which shall be got validated/ approved by GC/ NCRTC.**

Following other points needs to be noted-

1. The BIM models shall be set at the correct latitude and longitude or defined survey point.
2. Real-world coordinate systems to be used and models to be produced to true height above project datum
3. Orientation of the project shall be based on true/actual north
4. Sub-models of a single stretch or a building shall share the same survey point and coordinates.
5. All the models produced in Revit and Civil 3D shall use the 'shared coordinates' system.
6. Since the consultants also needs to share all information in IFC format, the consultants should ensure that the geo-referenced coordinates should also get successfully transferred into IFC format.

3.7. Level of Definition (LOD) – Principles & Requirements

3.7.1. LOD Principles

The Level of Definition is a collective term used to describe both the '**Level of Model Detail**' (LOD) and the '**Level of Model Information**' (LOI) for an element, to be authored and issued to the Employer by the Supplier.

The '**Level of Model Detail**' is the description of **graphical** content of models which is required during each (applicable) project stage.

The '**Level of Model Information**' is the description of **non-graphical** content of models which is required during each project phase.

These principles are based on UKs PAS 1192-2:2013.

[Table 4](#) declares NCRTC's overall vision and principles for modelling, LOD and LOI across the project lifecycle.

Table 4: Generic Principles of Levels of Model Definition for building and infrastructure projects⁶

Generic Principles of Levels of Model Definition for building and infrastructure projects						
Project Stage	Concept Design Stage	Preliminary Design Stage	Definitive Design & Construction Documentation Stage	Construction Stage	Handover Stage	Operations
What the model can be relied upon for	<p>Models which communicate the initial response to the brief, aesthetic intent and outline performance requirements. The model can be used for early design development, analysis and co-ordination.</p> <p>Model content is not fixed and may be subject to further design development.</p>	<p>A dimensionally correct and coordinated model which communicates the response to the brief, aesthetic intent and some performance information that can be used for analysis, design development and early contractor engagement.</p> <p>The model can be used for co-ordination, sequencing and estimating purposes including the agreement of a first stage target</p>	<p>A dimensionally correct and model that can be used to verify compliance with regulatory requirements.</p> <p>The model can be used as the start point for the incorporation of specialist contractor design models and can include information that can be used for fabrication, co-ordination, sequencing and estimating purposes, including the</p>	<p>An accurate model of the asset before and during construction incorporating coordinated specialist subcontract design models and associated model attributes. The model can be used for sequencing of installation and capture of as installed information.</p>	<p>An accurate record of the asset as constructed at handover, including all information required for operation and maintenance.</p>	<p>An updated record of the asset at a fixed point in time incorporating any major changes made since handover, including performance and condition data and all information required for operation and maintenance.</p>

Generic Principles of Levels of Model Definition for building and infrastructure projects						
Project Stage	Concept Design Stage	Preliminary Design Stage	Definitive Design & Construction Documentation Stage	Construction Stage	Handover Stage	Operations
		price.	agreement of a target price/guaranteed maximum price.			

⁶ Reference taken from UK PAS 1192-2:2013/ ISO19650

3.7.2. Model Production and Delivery Table (MPDT)

A reference to MPDT Template is present in [Annexure A – Model Production Delivery Table](#). A template for MPDT will be provided to Suppliers along with this EIR. This MPDT template will be developed and used for NCRTC projects **to define the Level of Detail (LoD) and Level of Information (LoI) by respective discipline experts to support the accessibility/usability of the models in all stages as defined in Table 4 above.**

MPDT to meet following requirements:

- i) the **Employer's BIM objectives** (as listed in Section 'Purpose of Document' within this document)
- ii) the **Employer's BIM Uses** (as listed in Section 3.1 of this document)
- iii) the **Supplier's required stage-wise scope of work** (as listed in the 'Scope of Work' document for the appointment of Supplier)
- iv) [Table 4: Generic Principles of Levels of Model Definition for building and infrastructure projects](#)
- v) **Exclusions in the model** (as per Section 3.11 of this document)

3.8. 2D Graphical Output

Information cross-sectioned from the model will also be shared using traditional drawing conventions. All 2d drawings produced as part of the project deliverables needs to be extracted out from the BIM models and following NCRTC's BIM Standards.

3.9. Design & Services Coordination

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

In early coordination processes, entire models can be run against other models to determine the scope of interference, i.e. objects, elements and selection criteria, for future testing. **However, it is important to recognize that not all conflicts detected are problems.** Certain conflicts may have been intentional during the modelling process for the sake of simplifying the modelling process.

Proper search sets/ element grouping, and clash rules should be set up before running the respective coordination processes, to:

- Reduce time and resources spent on detecting false positives.
- Hide elements that are unnecessary in the coordination process, for example, known issues that are to be resolved in later project stages; elements that do not impact cost when changed on site, etc.
- Group elements for a specific type of coordination process, such as forming groups between a ceiling search set and a MEP model only during a clash analysis.
- Clash results need to be judged in the context of the elements being analysed, and the type of clash detection software being used. For example, one issue that may occur are duplicate instances of the same clash – for example, a pipe hitting steel could represent 20 clashes when it is only one single issue.

Note- In response to this EIR, the Supplier is required to provide his/her strategy to ensure that no design and services coordination issues exist in the model. Details of clash tests (hard and soft clashes) which the supplier shall be running and tolerances for respective clash tests to be documented in the post-contract BIM Execution Plan submitted by the supplier.

3.10. Geometric Quality Assurance & Quality Control

The section shall be read in conjunction with NCRTC BIM standards-

3.10.1. General

- Geometric & non-geometric richness of the information in each stage shall be as per Model Production and Delivery Table.
- Drawing sheets shall be created within the modelling environment to ensure accuracy and coordination; all sheets must remain in the Building Information Models. Refer Section 3.8 2D Graphical Output for details. A sheet production model may be created in order to comply with Section 3.5-System Performance.
- All project Building Information Models shall comply with this document and NCRTC BIM Standards.
- All walls shall be properly joined to prevent “space leaks” in areas defined by enclosing walls.
- Representations of model component’s material specifications and scopes shall be modelled correctly and accurately in respect to the actual physical materials of the components to allow for material take-off and accurate design calculations.
- Once models from other disciplines are available, they must be used as linked files. Same element must not appear in more than one model.

3.10.2. Data Segregation

This section deals with the principles of sub-dividing a model for the purposes of:

- Multi-user access
 - Operational efficiency on large projects
 - Inter-disciplinary collaboration
- Following practices shall be followed-
- No more than one building shall be modelled in a single file.
 - A model file shall contain data from one discipline/ project stakeholder only (although exceptions may apply)
 - Further segregation of the geometry may be required to ensure that the model files remain workable on available hardware.
 - If a Building Information Model reached the size of 150 MB, consultants should consider segregating the model to reduce individual file sizes. If it is deemed reasonable by the project team, this limit may be increased or decreased and the same shall be recorded in post-contract BIM Execution Plan.
 - All discipline models for metro stations are required to be split by floors or by group of floors.

Note- GC/Contractor need to define their strategy with examples as how will they be dividing the BIM models into volume. This strategy shall be defined separately for station, depot, via-duct and tunnel (as applicable in the scope of work). This document is to be submitted for approval post award of contract.

3.10.3. BIM validation prior to model sharing

Checks for validation of the BIM model data prior to sharing:

- All extraneous drawings sheets (i.e. those deemed to not be a deliverable) should be removed from Building Information Models.
- Model or AutoCAD Xrefs have been audited and purged.
- File format and naming conventions conform to NCRTC BIM Standards and remain constant for the life span of the project.
- Data segregation conforms to project requirements.
- 3D model and 2D drawings are up to date and that the 2D information has been derived from the 3D model.
- All objects in a 3D default view must be made visible.
- All models to be developed using the shared coordinate system defined at the outset of the project.

3.11. Exclusions in Model

Following items can be excluded to be modelled in 3D by the Supplier. However, this does not relinquish the design author of the responsibility to provide this information. Such information, as possible (depending on the nature of the information) should be included in parameters within the BIM models and/or should be provided in design drawings (2D standard details).

- Final finishing items, such as skirting's, architraves and grouting.
- Architectural and structural elements which fits in 100mm x 100mm x 100mm cube.
- Electrical conduits, wire or cable less than 25mm dia.
- Internal plaster and paint in metro stations and depot. However, information regarding this shall be provided in attributes in respective model objects and/or in 2D drawings (as deemed fit by the model author/s).
- Hardware accessories in doors and windows
- Temporary works- Temporary works like formwork, false work, propping, facade retention, needling, edge protection, temporary bridges, site hoarding & site-signage, site fencing, scaffolding, tower cranes, loading bays and shoring is not required to be modelled except for structures intended to be permanently installed and not dismantled after construction.

Note-

1. Although the details of geometric (LOD) and non-geometric information (LOI) which will be entered within the BIM models will be compiled and referred from Model Production and Delivery Table, this section has been included to explicitly and separately list down the construction items which shall not be modelled in 3D, to bring quick and immediate clarity to all stakeholders.
2. The above exclusion requirements are provided keeping in mind the listed BIM uses defined in Section 3.1 of this document. Although, in some BIM uses some of the above listed exclusions may not hold valid. The decision regarding these exclusion will be based on industry best practices and the decision of the Engineer in charge will be final and binding.

For example-

- if **fabrication level BIM model** is being provided by the Supplier, then the condition '*Structural elements which fits in 100mm x 100mm x 100m cube*' may not be valid.
- For the BIM Use, '**4D simulation of construction sequencing (as applicable for respective DDC packages) and 4D Simulation of traffic diversion plans**', the above listed condition '*Temporary works like formwork, false work, propping, facade retention, needling, edge protection, temporary bridges, site hoarding & signage, site fencing, scaffolding, tower cranes, loading bays and shoring is not required to be modelled except for structures intended to be permanently installed and not dismantled after construction*' may not be valid.

3.12. Training

NCRTC is not responsible for providing training with regards to any BIM based software application being used by the consultants and contractors or their supply chain. It is a requirement that all individual parties are fully trained over the BIM tools prior to project engagement.

4. Competence

4.1. Knowledge and skill requirements

GC and contractors shall demonstrate knowledge of the underlying processes required to support BIM uses. This will involve communicating and recording intended methodology to successfully execute a BIM Use, which should be shared with NCRTC for confirmation prior to implementation.

All project team members are responsible for procuring training within their own organization and are required to undertake required training to efficiently meet the requirements of the project.

Experience, knowledge and skills of the appointed suppliers must be competent enough to undertake processes required to achieve the required BIM Uses. If design consultants and contractors fail to meet these requirements, they are required to improve skill sets or recruit additional technical staff before implementing BIM processes

5. Management

5.1. Roles and responsibilities

All stakeholders shall utilize BIM information distributed via the Common Data Environment (CDE) to validate the Building Information Models at key project stages. The following should be reported to **NCRTC** immediately upon discovery-

- Discrepancies in the model which may cause inaccuracies
- The validity of the data structure within the model and adherence to the data structure defined in the project BIM Execution Plan. As specified in the Section 2 [Applicable Standards](#) COBie-UK-2012 schema is to be implemented.
- Instances where out of date information is contained within any of the BIM models.

5.2. Document naming protocol

Model naming conventions shall be as per NCRTC BIM Standards.

5.3. Common Data Environment

Stakeholders are responsible for storing and maintaining a copy of all project information in a secure stable location within their own organization and will make information available to the project team and **NCRTC** over the Common Data Environment (CDE). Employer will have access to native and exchange BIM files at any point.

Since, CDE will be implemented for the smooth execution of the project, only online CDE platforms to be used for

1. Transmittal, Review, Approvals and Release of all Drawings and Documents. This includes online Commenting and Inter-Departmental Checks (IDC) and Comments.
2. All Incoming and Outgoing Correspondences with DDC, GC and Contractors.
3. Maintenance of Project related Correspondences with external agencies and stakeholders.
4. Maintenance of site-related documents like Checklists, Records, Deviations, Variations etc.
5. Requests for Information (RFI) and its Reply/Compliance

The Common Data Environment (CDE) for this project, file naming and location structure will be confirmed within the BIM Execution Plan. The folder structure within the CDE will be in line with that detailed in PAS 1192-2:2013.

5.4. Security

All project information is to be treated with confidence unless explicitly agreed with **NCRTC**. All consultants and contractors and their sub-consultants are required to adopt this policy. All BIM information will be exchanged in the Common Data Environment (CDE).

To support security and accessibility of information, folder locations and upload purposes must be strictly adhered to. Any amendments to the naming or structure of the Common Data Environment (CDE) workspace must be explicitly agreed with the project team and **NCRTC**.

5.5. Process Mapping

In reference to [Table 2: BIM Uses](#), the Supplier is required to provide details of the workflow and collaboration process that will be undertaken in the production of the BIM models, to

address the BIM uses (against which the Supplier is providing services). Provision of information from suppliers should be sufficient to demonstrate competence and capability, responsible party and format of exchange of information. Process Mapping details to be submitted for approval post award of contract.

6. Commercial

Post award of contract, the Supplier shall respond to this EIR by submitting a BIM Execution Plan(BEP) for approval, the template for which shall be shared by **NCRTC**.

7. Glossary of Abbreviations and Terms

7.1. Abbreviations

BEP	BIM Execution Plan
BIM	Building Information Modelling
PIM	Project Information Model
AIM	Asset Information Model
BIMs	Building Information Models
CDE	Common Data Environment
DDC	Detailed Design Consultant
EIR	Employer Information Requirement
IFC	Industry Foundation Class
LOD	Level of Definition
LOI	Level of Information
MPDT	Model Production Delivery Table
WIP	Work In Progress
COBie	Construction Operations Building Information Exchange

7.2. Glossary of Terms

4D BIM	A 3D representation of an asset with the element of time included to enable simulations.
5D BIM	A 3D representation of an asset with the element of cost included to it.
4D + 5D BIM	A 3D representation of an asset with the element of cost included to enable simulations, commercial management and earned value tracking to take place.
BIM	Process of designing, constructing or operating a building or infrastructure asset using electronic object-oriented information
BIM Execution Plan (BEP)	Plan prepared by the suppliers, facilitated by the Employer or the Employer's BIM representative to explain how the

	information modelling aspects of a project will be carried out
COBie	Structured facility information for the commissioning, operation and maintenance of a project often in a neutral spread sheet format that will be used to supply data to the employer or operator to populate decision-making tools, facilities management and asset management systems
CDE (Common Data Environment)	Single source of information for any given project, used to collect, manage and disseminate all relevant approved project documents for multi-disciplinary teams in a managed process.
Data	Information stored but not yet interpreted or analysed
Design intent model	Initial version of the project information model (PIM) developed by the design suppliers
Drawing	Static, printed, graphical representation of part or all have a project or asset
Employer	Individual or organization named in an appointment or building contract as the employer
EIR	Pre-tender document setting out the information to be delivered, and the standards and processes to be adopted by the supplier as part of the project delivery process
Federated BIM Model	A federated model is a combined Building Information Model that has been compiled by amalgamating several different models into one (or importing one model into another).
Graphical Data	Data conveyed using shape and arrangement in space
Level of Definition	Collective term used for and including “level of model detail” and the “level of information detail”
Post-contract BEP	The post-contract BEP is the document defining standard methods and procedures adopted during the contract in order to meet the objectives and requirements set forth in the EIR. It is utilised following the appointment of project stakeholders.
Volume	Manageable spatial subdivision of a project, defined by the project team as a subdivision of the overall project that allows more than one person to work on the project models simultaneously and consistent with the analysis and design process

Annexure A – Model Production Delivery Table

							Preliminary Design Stage			Definitive Design & Construction Documentation Stage			Construction Stage (Build & Commission)			Handover Stage			Operation In Use		
DELIVERABLE	Element Code Uniclass 2015	Element Title Uniclass 2015	Metro Station	Depot	Viaduct	Tunnel	Responsible Party	LEVEL OF DEFINITION		Responsible Party	LEVEL OF DEFINITION		Responsible Party	LEVEL OF DEFINITION		Responsible Party	LEVEL OF DEFINITION		Responsible Party	LEVEL OF DEFINITION	
								LOD	LOI		LOD	LOI		LOD	LOI		LOD	LOI		LOD	LOI
Structural Model Development																					
Substructure	EF_20_05	Substructure																			
Frames (All types of Structural frames; e.g. Braced)	EF_20_10	Frames																			
Beams	EF_20_20	Beams																			
Columns	EF_20_30	Columns																			
Bridge abutments and piers	EF_20_50	Bridge abutments and piers																			
Barriers	EF_25_55	Barriers																			
Roofs	EF_30_10	Roofs																			
Floors	EF_30_20	Floors																			
Bridge decks	EF_30_70	Bridge decks																			
Tunnels and shafts	EF_37_50	Tunnels and shafts																			
Rail tracks	EF_80_70	Rail tracks																			

Concrete foundation systems	Ss_20_05_15	Concrete foundation systems																			
Minor concrete substructure systems	Ss_20_05_50	Minor concrete substructure systems																			
Piling systems	Ss_20_05_65	Piling systems																			
Structural framing systems	Ss_20_10_75	Structural framing systems																			
Framed wall structure systems	Ss_25_10_32	Framed wall structure systems																			
Concrete wall systems	Ss_25_11_16	Concrete wall systems																			
Structural glass wall systems	Ss_25_12_80	Structural glass wall systems																			
Structural stair and ramp systems	Ss_35_10_85	Structural stair and ramp systems																			
Architectural Model Development																					
Construction sites	EF_15_15	Construction sites																			
Walls	EF_25_10	Walls																			
Doors and windows	EF_25_30	Doors and windows																			
Pavements	EF_30_60	Pavements																			
Stairs	EF_35_10	Stairs																			
Ramps	EF_35_20	Ramps																			
Vessels and trenches	EF_37_16	Vessels and trenches																			
Furnishings	EF_40_30	Furnishings																			
Planted elements	EF_45_10	Planted elements																			

Grassed elements	EF_45_20	Grassed elements																			
Fauna elements (common animals)	EF_45_30	Fauna elements																			
Transport functions	EF_80	Transport functions																			
Cable transport	EF_80_10	Cable transport																			
Conveyors	EF_80_20	Conveyors																			
Shelter systems (Shelter stop for Metro passengers)	Ss_20_10_7 0	Shelter systems																			
Curtain walling systems	Ss_25_10_2 0	Curtain walling systems																			
Framed partition systems	Ss_25_10_3 0	Framed partition systems																			
Framed glazed systems	Ss_25_10_3 5	Framed glazed systems																			
Panel cubicle systems	Ss_25_12_6 0	Panel cubicle systems																			
Panel partition systems	Ss_25_12_6 5	Panel partition systems																			
Glass wall systems	Ss_25_13_3 3	Glass wall systems																			
Masonry wall systems	Ss_25_13_5 0	Masonry wall systems																			
Board cladding systems	Ss_25_20_0 8	Board cladding systems																			
Composite panel cladding systems	Ss_25_20_1 4	Composite panel cladding systems																			
Concrete cladding systems	Ss_25_20_1 5	Concrete cladding systems																			
Glass fibre reinforced concrete (GRC)	Ss_25_20_3 3	Glass fibre reinforced concrete (GRC) cladding																			

[illegible]

Note- This is just a snap of a part of a suggested MPDT template. Editable copy of this template will be provided to the Suppliers.