4D BIM SIMULATION REQUIREMENTS

1   4D BIM FOR PROGRAMME PLANNING

1.1   The Contractor shall utilise 4D BIM for the planning and visualisation of the construction and installation sequence and programme.

1.2   **4D BLP** shall refer to the 4D BIM simulation of the baseline programme.

1.3   **4D CIP** shall refer to the 4D BIM simulation of the Co-ordinated Installation Programme.

1.4   **4D BIM SIMULATION OF THE BASELINE PROGRAMME (4D BLP)**

1.4.1   The Contractor shall utilise 4D BIM for the simulation of baseline programme to demonstrate the sequence of the construction works.

1.4.2   The Contractor shall submit the 4D BIM BLP two (2) months following the Preliminary Design submission using the submitted BIM model. The subsequent submission shall be made one (1) month following the Final Design submission. All submissions shall be subjected to the acceptance of the Engineer.

1.4.3   Where required by the Engineer, the Contractor shall submit a 4D BIM simulation of the revised baseline, recovery or working programme within 2 weeks upon such request, unless otherwise agreed with the Engineer. The requirements for such 4D BIM simulations shall be in accordance with the requirements for the 4D BLP.

1.4.4   Unless otherwise agreed with the Engineer, the 4D BLP shall capture all activities in the programme with the exception of the following:

(a)   preliminaries and other time-based activities;

(b)   design activities;

(c)   off-site procurement and fabrication activities; and

(d)   testing, commissioning, and inspection activities.

Notwithstanding the above, the 4D BLP shall provide a good appreciation of the following:

(a)   traffic diversion works, including the existing road conditions;

(b)   utility diversion works, including the existing location of the utilities to be diverted;

(c)   major excavation works, including all strutting, shoring, temporary openings and closing of these temporary openings;

(d)   movement of major equipment, including lifting frames, launching gantries, tunnel boring machines etc.;

(e)   major infrastructure within the contract boundary including existing road infrastructures, rail viaducts and tunnels; and

(f)   all other relevant programme constraints.

Where appropriate, geometric representations may be used to represent elements which are not part of the permanent structural model, subject to acceptance by the Engineer.

1.4.5   For all 4D BLP submissions, the 4D BIM source file shall include both the planned early and late dates as captured in the programme. The video files for the first submission of the 4D BLP shall be based on the planned late dates of the baseline programme. The video files for subsequent submissions of the 4D BLP shall be based on the planned early dates of the baseline programme unless otherwise requested by the Engineer.

1.4.6   Colour Conventions

All submissions of the 4D BLP shall adopt colour conventions to differentiate between different activity types, which include, but not limited to, the following:

(a)   Construction or installation activities;

(b)   Demolition activities;

(c)   Temporary activities; and

(d)   Not active.

1.5 4D BIM SIMULATION OF THE CO-ORDINATED INSTALLATION PROGRAMME (4D CIP)

1.5.1 The Contractor shall utilise 4D BIM for the coordination, planning and development of the CIP. The simulation shall be sufficiently detailed to illustrate the sequence of the installation activities.

1.5.2 This section shall be read in conjunction with the requirements in General Specifications Appendix E for the Co-ordinated Installation Programme.

1.5.3 The Contractor shall be responsible for the production of 4D CIP via model-based scheduling. This shall be achieved through co-ordination and incorporation of the installation activities using the Coordinated Combined Services Model (CCSM) as the basis.

1.5.4 The 4D CIP shall be prepared in collaboration among the Contractor and the System-Wide Contractors. Specifically, the Contractor shall propose the conventions, rules, workflows and processes to be used for coordination with the System-Wide Contractors. This set of workflows and processes shall then be agreed upon with all System-wide Contractors prior to the commencement of interfacing meetings for the 4D CIP.

1.5.5 The Contractor shall commence interface meetings with the System-Wide Contractors on the 4D CIP following the acceptance of the Final Design CCSM. During such interface meetings, the Contractor shall take the lead to develop the 4D CIP using the Final Design CCSM, jointly with the System-wide Contractors based on the provision of relevant programme information and sequence of work from respective parties.

1.5.6 The 4D CIP shall show the access duration for activities at each location and sequence of installation for the work items in the CCSM. The Contractor shall ensure that the sequence of works as planned in the 4D CIP are logical and optimal, taking into consideration the space constraint of having multiple parties working in the same areas.

1.5.7   In addition to the requirements in General Specifications on the format and requirement of the Co-ordinated Installation Programme, the 4D CIP shall also comply with the following requirements:

(a)   4D BIM workspace shall include a BIM model window for displaying the selected room/area of the CCSM and a window for displaying the activity table and Gantt chart;

(b)   each programme activity shall be correctly attached to the corresponding model element(s)/object(s);

(c)   differentiated colour schemes shall be defined to differentiate the activities of different contractors;

(d)   differentiated colour schemes shall be defined to differentiate the activities based on their activity type (e.g., new installation, temporary, demolition, inactivity); and

(e)   the colour schemes shall be proposed and agreed with the Engineer and applied on the 4D BIM model during the simulation.

1.5.8   The Contractor shall extract the programme task list and Gantt chart of the 4D CIP in PDF or any format requested by the Engineer for sign-off amongst the respective contractors' Project Managers. The Contractor shall then submit the signed-off CIP together with the native 4D BIM file to the Engineer for acceptance.

1.6   4D BIM CONTENT REQUIREMENTS, STANDARDS AND SUBMISSION FORMATS

1.6.1   Submission Format

All 4D BIM deliverables shall be submitted in Bentley Synchro 4D software editable format. All 4D BIM deliverables shall also include videos in a readable format for Windows Operating System.

1.6.2   All 4D BIM deliverables shall also be submitted with an accompanying document that details how the 4D BIM simulation is developed. Where applicable, it shall include:

(a)   list of BIM files submitted, indicating the file name and description of each file;

(b)   list of video files submitted, indicating the file name and description of each file;

(c)   list of BIM model(s) used, including the design stage and design cut-off date;

(d)   list of programme(s) used (where applicable), indicating the revision number, and submission date;

(e)   list of viewpoints;

(f)   list of BIM elements that are not attached to any activity, and explanation for why they are not attached;

(g)   list of BIM elements that are attached to multiple activities, and explanation for why they are attached to multiple activities;

(h)   list of activities that do not have any elements attached;

(i)   list of activities omitted from the 4D simulation; and

(j)   list of comments raised to previous submissions, and the corresponding reply to these comments.

This shall not prevent the Engineer from requiring the Contractor to provide further details as required to assist him in his review and appreciation of the 4D BIM submission.

1.6.3   Viewpoints

All 4D BIM deliverables shall include multiple viewpoints, sufficiently zoomed in to clearly illustrate the work sequence in each work area. Each viewpoint shall be named with the location and the orientation shown (e.g. station plan view). The list of viewpoints, subject to the Engineer's acceptance, shall be saved and made retrievable in the BIM file submitted. The video deliverables shall correspond to the list of viewpoints, with each video capturing each single viewpoint.

1.6.4   Animation

The Contractor shall make use of the appropriate animation types to accurately demonstrate the methodology, sequence, direction and scope of major works as indicated in the programme.

1.6.5   Wayfinding Conventions and Points of Reference

All 4D BIM deliverables shall include points of references and wayfinding conventions in the simulation to orientate the Engineer. The accessory conventions may include:

(a)   Station Gridlines;

(b)   Contract Boundaries;

(c)   Simulation Boundaries;

(d)   Wayfinding Conventions;

(e)   Localised Zoning;

(f)   Pier Number; and

(g)   Chainage Intervals.

1.6.6   All attachments between programme activities and model elements shall be done correctly, including but not limited to the scope of work, location and quantity.

1.7   **BIM EXECUTION PLAN (BEP) REQUIREMENTS FOR 4D BIM FOR PROGRAMME PLANNING**

1.7.1   The 4D BIM chapter in the Contractor's BEP shall be sufficient to explain clearly how the Contractor intends to meet the requirements specified in Clause 1 of BIM Annex D.

2   4D BIM FOR CONSTRUCTION SAFETY APPLICATION

2.1   The Contractor shall identify all high-risk construction activities and ensure that the respective method statement (approved by the Engineer) is documented in the BEP.

2.2   The Contractor shall submit 4D BIM simulation to provide visualisation on the work area, identify associated work hazards and highlight the control measures to mitigate the hazardous work conditions. The Contractor shall ensure the 4D BIM simulation is approved by the Engineer prior to work commencement.

2.3   The 4D BIM simulation shall include, but not limited to:

2.3.1   Deployment plan of plant and machinery at site, and demarcation of dedicate walkways for workers and machineries onsite.

2.3.2   Detailed construction sequence and its corresponding potential work hazards with explanation that workers can comprehend on how the hazards can be mitigated and controlled.

2.3.3   The following software features:

(a)   Machineries onsite (e.g. Lifting Machines, Boring Machines, Deep Soil Mixing Machines, etc.);

(b)   Workers with required PPE deployed on site (e.g., Lifting team, Banksman, Welders, etc.);

(c)   Actual site working environment for each work activity which may also impact the safety of workers during day and night time;

(d)   Demarcation of safe working zone around the machines (e.g., Lifting Zone, Crane Radius, etc.); and

(e)   Safe position that the workers should take to prevent standing in-line of fire during each stage of the construction sequence.

2.4   Upon request by the Engineer, the Contractor shall submit 4D BIM Deliverables in a readable video format compatible to Windows Operating System, for the Engineer's acceptance.

2.5   The Contractor shall utilise the approved 4D BIM simulation for safe work briefings to workers prior to work commencement.