

Maha Metro



Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 1 - Drawing List

June 2018

DRAWING LIST

Drawing Number	Drawing Title	Remark
GENERAL DRAWINGS		
PML1-IC-GA-UGC-0001	Layout of Contract UGC01 & UGC02	
PML1-IC-GA-UGC-0001	Typical Details Of Temporary Barricading	
WORKS AREA		
PML1-IC-WA-BDP-0212	Proposed Work Area For Budhwar Peth Station	
PML1-IC-WA-MND-0211	Proposed Work Area For Mandai Station	
PML1-IC-WA-SWG-0213	Proposed Work Area For Swargate Station	
ALIGNMENT		
PML1-IC-AL-UGC-0221	Alignment Drawing - Arrangement of Plan & Longitudinal Section	
PML1-IC-AL-UGC-0222	Alignment Drawing - Arrangement of Plan & Longitudinal Section	
PML1-IC-AL-UGC-0223	Alignment Drawing - Arrangement of Plan & Longitudinal Section	
PML1-IC-AL-UGC-0224	Alignment Drawing - Arrangement of Plan & Longitudinal Section	
PML1-IC-AL-UGC-0225	Alignment Drawing - Arrangement of Plan & Longitudinal Section	
GEOTECHNICAL		
PML1-IC-GP-UGC-0231	Geology and Geotechnical Plan View and Longitudinal Section	
PML1-IC-GP-UGC-0232	Geology and Geotechnical Plan View and Longitudinal Section	
PML1-IC-GP-UGC-0233	Geology and Geotechnical Plan View and Longitudinal Section	
PML1-IC-GP-UGC-0234	Geology and Geotechnical Plan View and Longitudinal Section	
PML1-IC-GP-UGC-0235	Geology and Geotechnical Plan View and Longitudinal Section	
ARCHITECTURAL		
PML1-IC-BDP-ARC-0241	Budhwar Peth Station Street Level Plan	
PML1-IC-BDP-ARC-0242	Budhwar Peth Station Mezzanine Level 1 Plan	

DRAWING LIST

Drawing Number	Drawing Title	Remark
PML1-IC-BDP-ARC-0243	Budhwar Peth Station Mezzanine Level 2 Plan	
PML1-IC-BDP-ARC-0244	Budhwar Peth Station Mezzanine Level 3 Plan	
PML1-IC-BDP-ARC-0245	Budhwar Peth Station Platform Level Plan	
PML1-IC-BDP-ARC-0246	Budhwar Peth Station Entrance 1	
PML1-IC-BDP-ARC-0247	Budhwar Peth Station Sections	
PML1-IC-MND-ARC-0251	Mandai Station Street Level Plan	
PML1-IC-MND-ARC-0252	Mandai Station Mezzanine Level 1 & 2 Plan	
PML1-IC-MND-ARC-0253	Mandai Station Platform Level Plan	
PML1-IC-MND-ARC-0254	Mandai Station Sections	
PML1-IC-MND-ARC-0255	Mandai Station Entrance 1	
PML1-IC-MND-ARC-0256	Mandai Station Entrance 2	
PML1-IC-SWG-ARC-0261	Swargate Station Street Level Plan	
PML1-IC-SWG-ARC-0262	Swargate Station Concourse Level Plan	
PML1-IC-SWG-ARC-0263	Swargate Station Mezzanine Level Plan	
PML1-IC-SWG-ARC-0264	Swargate Station Platform Level Plan	
PML1-IC-SWG-ARC-0265	Swargate Station Sections	
PML1-IC-SWG-ARC-0266	Swargate Station Entrances	
PML1-IC-STN-ARC-0271	Design Intent Public Areas	
PML1-IC-STN-ARC-0272	Design Intent Architectural Elements	
PML1-IC-STN-ARC-0273	Design Intent Architectural Elements	
ELECTRICAL SERVICES		
PML1-IC-GA-EL-0005	General Electrical Symbols	

DRAWING LIST

Drawing Number	Drawing Title	Remark
PML1-IC-GA-EL-0006	General Electrical Symbols	
PML1-IC-GA-EL-0007	Electrical Typical Details	
PML1-IC-GA-EL-0008	Electrical Typical Details	
PML1-IC-GA-EL-0009	Electrical Typical Details	
PML1-IC-GA-EL-0010	Electrical Typical Details	
PML1-IC-GA-EL-0011	Typical Earth Mat Schematic	
PML1-IC-GA-EL-0012	Typical Earth Mat Schematic	
PML1-IC-GA-EL-0013	Lighting Control Schematic	
PML1-IC-GA-EL-0014	PWR Distribution Schematic	
PML1-IC-GA-EL-0015	Typical LV Schematic	
PLUMBING		
PML1-IC-GA-PL-0021	Plumbing - General Notes and Legends	
PML1-IC-GA-PL-0022	Water Supply Schematic	
PML1-IC-GA-PL-0023	Plumbing Typical Details	
PML1-IC-GA-PL-0024	Plumbing Typical Details	
PML1-IC-GA-PL-0025	Plumbing Typical Details	
PML1-IC-GA-PL-0026	Typical Station Drainage Schematic	
FIRE ALARM SYSTEM		
PML1-IC-GA-FA-0031	Fire Alarm System - General Notes and Legends	
PML1-IC-GA-FA-0032	Fire Alarm Schematic	
PML1-IC-GA-FA-0033	Fire Alarm System - Typical Details	
FIRE FIGHTING SYSTEM		

DRAWING LIST

Drawing Number	Drawing Title	Remark
PML1-IC-GA-FF-0041	Fire Fighting System - General Notes and Legends	
PML1-IC-GA-FF-0042	Fire Fighting System - Fire Fighting Schematic	
PML1-IC-GA-FF-0043	Fire Fighting System - Typical Layout	
PML1-IC-GA-FF-0044	Fire Fighting System - Fire Plant Room - G.A Plan	
PML1-IC-GA-FF-0045	Fire Fighting System - Typical Details	
TUNNEL AND CROSS-PASSAGES		
PML1-IC-RT-CP-0051	Arrangement of Cross Passage Without Sump	
PML1-IC-RT-CP-0052	Arrangement of Cross Passage With Sump	
PML1-IC-RT-CS-0053	Arrangement of Running Twin Bored Tunnel	
PML1-IC-RT-CS-0054	Arrangement of Running Tunnel Segment And Geometry	
PML1-IC-RT-CS-0056	Arrangement of Running Tunnel Steel Walkway and ladder details	
PML1-IC-RT-CS-0058	Arrangement of NATM Cross Over Section at Swargate Station	
PML1-IC-RT-CS-0059	Typical NATM Cross- Section at Swargate Station	
INSTRUMENTATION AND MONITORING DRAWINGS		
PML1-IC-GA-IM-0061	Instrumentation and Monitoring Drawing - General Notes	
PML1-IC-GA-IM-0062	Instrumentation and Monitoring Drawing - General Notes	
PML1-IC-GA-IM-0063	Instrumentation and Monitoring Drawing - Typical Details	
PML1-IC-GA-IM-0064	Instrumentation and Monitoring Drawing - Typical Details	
PML1-IC-GA-IM-0065	Typical Section For TBM Tunnel and Cross Passages	
PML1-IC-GA-IM-0066	Details For Arrays For Cut & Cover Structure, Launch Shaft	
INTERFACE DRAWINGS		
PML1-IC-GA-IRF-0071	Services in Bored Tunnel	

DRAWING LIST

Drawing Number	Drawing Title	Remark
PML1-IC-GA-IRF-0072	Trench Details for Gates	
PML1-IC-GA-IRF-0073	Ticket Office Counter	
PML1-IC-GA-IRF-0074	M&E Scada Architecture	
PML1-IC-GA-IRF-0075	Interface B/W Fire FF & ESC	
PML1-IC-GA-IRF-0076	Typical Earth Mat Layout	
PML1-IC-GA-IRF-0077	Drainage for VAC	
PML1-IC-GA-IRF-0078	Control Philosophy	
PML1-IC-GA-IRF-0079	Division of Scope	
PML1-IC-GA-IRF-0080	Wall Ceiling Detail for VAC	
PML1-IC-GA-IRF-0081	Wall Ceiling Detail for TVS	
PML1-IC-GA-IRF-0082	Details for TES & UPS	
PML1-IC-GA-IRF-0083	Pedestal Details-TVS	
PML1-IC-GA-IRF-0084	Pedestal Details-ECS	
PML1-IC-GA-IRF-0085	TVS Electrical Arrangement	
PML1-IC-GA-IRF-0086	Scope Demarcation in ASS Rooms	
PML1-IC-GA-IRF-0089	Jet Fan Locations - 3	
PML1-IC-GA-IRF-0090	Jet Fan Locations - 4	
UTILITY DRAWINGS		
PML1-IC-BDP-UTL-0296	Utility drawings for Budhwar Peth Station	
PML1-IC-MND-UTL-0297	Utility drawings for Mandai Station	

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PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 2A – Works Area

June 2018

WORKS AREA

- (1) The Site and works Areas will be made available to the Contractor at different times and for various durations as shown on the Schedule of Access Dates in this Appendix. These Site and works Areas are illustrated in the Employer's Drawings. Should there be any discrepancies in the definition of the extent of these Sites and Works Areas between the descriptions in this Appendix and the Employer's Drawings, the Employer's Drawings shall prevail.
- (2) The Employer may, however, give to the Contractor access to portions of the Site and Works Areas earlier than the time stated and the Contractor shall accept them. The Contractor shall not be entitled to any additional payment for early access of any portion of the Site or works Areas.
- (3) The descriptions of the Site and Works Areas given below are indicative and the Contractor shall satisfy himself as to the exact nature of the various Site and works Areas and the extent of works to be carried out prior to the execution of the Permanent Works or making use of the area as working space and/or for temporary site facilities.
- (4) The Contractor shall submit to the Engineer for a notice of no objection, a written proposal for the use and occupation of these Site and works Areas at least 6 week prior to the programmed use of the requested areas. The availability of Site and works Areas will only be permitted for the actual duration of the permanent and temporary works within the particular Site and works Areas. The Contractor shall comply with the Employer's Requirements as stated in Appendix 8 of this Section VI regarding the use of the Site and works Areas.
- (5) The Contractor is deemed to have acquainted himself with the actual location and conditions of the Site and allow for any contingency with regard to the means of access and any special Site restrictions including making good all works disturbed or damaged to match with the existing.
- (7) The Contractor shall propose controlled access points to the Site and works Areas from the existing roads in different periods for a notice from the Engineer. The Contractor shall not construct any temporary roadways which may be necessary to afford access to his Site and working Areas without a prior notice from the Engineer.
- (8) The Contractor shall ensure that all approved accesses shall not impose any constraints and hazard to existing establishments or to other works by Interfacing Contractors. If such accesses are required to be relocated, deleted or closed as may be directed by the Engineer, the Contractor shall do so at his own costs and time.
- (9) The Contractor shall maintain at all times all existing roads, road traffic, road accesses, traffic junctions, pedestrian routes and access to existing buildings within the Site and works Areas during all stages of the traffic diversion schemes he may propose for the execution of the Works. The Contractor shall submit his proposal, for a notice from the Engineer, after having received approval from all Relevant Authorities, for the provision of temporary accesses required at any existing building(s) to ensure continuation of access for the public and to facilitate construction of the Works.
- (10) Unless otherwise noted, the Contractor shall protect all existing buildings and structures, either located within or adjacent to, the Site and works Areas to the satisfaction of the Engineer.
- (11) If any land and/or right of way, other than the Site and works Areas shown on the Employer's Drawings, is required by the Contractor for the purpose of the execution of the Works, such as for temporary diversion, ground treatment, storage, site offices for

the Contractor or the Engineer, etc... the same shall be arranged by the Contractor at his own risk and cost. The Employer where feasible may at his discretion assist the Contractor in this respect.

(12) Schedule of Site Access Dates:

The land parcels as shown in Works Area Tender Drawings will be shared in piece and parcels based on the Contractor's construction programme and upon receipt of request from Contractor.

At Swargate Station the advanced Contract Package for Temporary walling Construction and construction of property development – UGC-04 will be working along side the Package 2 Contractor. The Works area sharing dates shall be coordinated and confirmed with advanced Contract Package and submitted for Engineer's Notice.

(13)

(13) Provision of Facilities and Access for Interfacing Contractors.

- a) The Contractor is obliged to coordinate with the Interfacing Contractors and provide storage (a fenced off area in accordance with the agreed schedule, including water, electricity connections and access to the road and track), staging and unloading areas for them, as required in the Contract. The Interfacing Contractors shall be required to maintain the fenced off area and access thereto, from when the Contractor has completed his Works and after the handover of the balance Site Areas from the Contractor to the Employer. The Interfacing Contractor will be responsible for security, clearing and reinstating this Site Area in accordance with the Contract. The Contractor shall be responsible for clearing and reinstating the remaining site areas not used by the Interfacing Contractor.
- b) All Site Areas shall be handed back to the Employer, with the exception of the fenced area and access for the Interfacing Contractor, within 28 days from the date of issue of the Taking Over Certificate. Prior to returning any Site Areas to the Employer, the Contractor shall carry out the following works:
 - (i) Construct all Permanent Works within the area in accordance with the requirements of the Contract;
 - (ii) Reinstatement the area to its original condition, or better, when it was taken over, except where the Contract requires construction of Permanent Works;
 - (iii) Propose final modifications / changes to the area, at locations where it is not possible or desirable to reinstate the area to its original condition, to the satisfaction of the Engineer, and form the area to the agreed lines and levels, and carry out such other works as may be required by the Engineer;
 - (iv) Removal of all rubbish, debris and other materials

(14) Interface Coordination for TBM Operations at Budhwar Peth Station

- (i) The Design and Construction of Underground Stations at Shivaji Nagar and Civil Court and Tunnels from Agricultural College Shaft to Budhwar Peth Station shall be done by the adjacent contractor (contract package UGC-01). The Contractor will have Civil and MEP works interface with the adjacent Civil Contractor at Budhwar Peth station. At the contract boundary with UGC-01 at Budhwar Peth Station, the Contractor shall co-ordinate and shall provide all sorts of help to UGC-01 to carry out any ground

treatment/improvement works, if required, for his TBM retrieval operations. The area required for the TBM operations etc and its duration shall be coordinated and agreed between the two Contractors depending upon the construction methodology and the Works Programme of the two Contractors, and it will be subject to the Notice of No Objection of the Engineer.

- (ii) If the Budhwar Peth station NATM portion is not ready in order to drag TBM (of Package 1) as mentioned above, following could apply based on the agreement in between UGC01 Contractor and Engineer.

UGC01 Contractor shall be allowed to bore through the TBM from NATM portion at Budhwar Peth station and retrieve the same from the cut & cover portion of Budhwar Peth station. The UGC02 Contractor shall later dismantle the temporary segment and increase the cavern to suite NATM station requirements. No additional cost shall be paid to the Contractor on account of change in methodology for NATM tunneling operation.

- (iii) The Contractor (UGC-01) shall be allowed to retrieve the Tunnel Boring Machines from Budhwar Peth station by dragging them back from the contract boundary to suitable point of retrieval as per his convenience. For this purpose the Contractor-UGC-02 shall interface with the UGC-01 Civil Contractor for the design and construction of the facilities that may be required in Budhwar Peth station's temporary and permanent works for enabling UGC-01 contractor (the Contractor) to break- through , such that all the enabling works and the designs & construction of Budhwar peth station are fully coordinated for ensuring compatibility and meeting construction programmes of the two contractors and as approved by the Engineer. The UGC-02 Contractor shall give UGC-01 Contractor the required access through the station at Budhwar Peth, if required as per the methodology. This access will be required for all the works associated with the UGC-01 Contractor's TBM retrieval and removal of TBM equipment. The Contractor UGC-02 shall allow for a reasonable duration for the handover period of the work area and access to the station for the Contractor in order for UGC-01 to complete his TBM dismantling and removal, as per the mutually consented methodology of retrieval. This duration shall be coordinated and agreed between the two Contractors, and it will be subject to the Notice of No Objection by the Engineer.
- (iv) At all times, both UGC-01 and UGC-02 Contractors shall ensure that suitable measures are taken to prevent any risks from flooding or water run-off to the adjacent Contractor's works. The measures shall be to the acceptance of the Engineer. Both UGC-01 and UGC-02 Contractors shall be fully responsible for their own temporary drainage systems to keep their respective work areas dry and free from flooding. Each Contractor shall provide their bulkhead where necessary.
- (v) The UGC-02 Contractor shall indemnify the Employer against all costs, charges and expenses resulting from his failure to properly co-ordinate the Works and the interfaces with UGC-01 Contractor. The UGC-02 Contractor shall allow in his programme the coordination and period of access from UGC-01 Contractor to carry out the works in Budhwar Peth Station duly interfacing the requirements.

(15) Interface Coordination for Sharing Works area and completed works by Advanced Contract at Swargate Station (UGC-04) :

- (i) Swargate station advanced Contract UGC-04 for the construction of temporary works along with the permanent property development work is under progress. UGC-02 Contractor shall coordinate with DDC for UGC03 Contract and give UGC-04 Contract DDC the inputs related to his permanent station scheme.
- (ii) UGC-02 as well shall give UGC-04 Contract DDC the TBM forces and requirements for mobilization of construction equipment's for him to take in to account the surcharge in him temporary construction scheme

OR

if UGC-04 contract has already progressed in his design and construction in such case UGC-02 shall respect the loading condition assumption given by UGC-04 Contract DDC.

- (iii) UGC-02 shall share his TBM launching programme with UGC-04 Contractor.
- (iv) UGC-02 Contract shall agree on sharing of work area with UGC-04 Contract
- (v) The UGC-02 Contractor shall indemnify the Employer against all costs, charges and expenses resulting from his failure to properly co-ordinate the Works and the interfaces with UGC-04 Contractor.
- (vi) Both UGC-02 and UGC-04 Contractors shall be fully responsible for their own temporary drainage systems to keep their respective work areas dry and free from flooding.
- (vii) The UGC-02 Contractor shall allow in his programme the coordination and period of access from UGC-04 Contractor to carry out the works in Swargate Station duly interfacing the requirements.

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**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
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PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 2B – Contract Key Dates & Completion Dates

June 2018

CONTRACT KEY DATES

Key Date for Employer/Engineer Site Office's:

Contractor shall establish a site office for Employer/Engineer at designated location within 45 days of from contract commencement date.

In case Contractor failed to do so a penalty of 0.0005 % of fixed lump sum quoted in Price center B per day of delay for the work will be incurred from Contractor.

Key Dates: Budhwar Peth Station

Key Dates	Description	Number of days from Commencement	Delay Damages for non-achieving the Key Dates
KD-1	Design Co-ordination and site investigations submission	140	0.025% of the fixed lump sum quoted in Price Centre "B" per day of delay for the Key date
KD-2	Preliminary Design Submission	182	0.025% of the fixed lump sum quoted in Price Centre "B" per day of delay for the Key date
KD-3	Completion Excavation for station box	308	0.025% of the fixed lump sum quoted in Price Centre "B" per day of delay for the Key date
KD-4A	Definitive Design Submission for Permanent Structures including Architectural and Structural for base slab	336	0.005% of the fixed lump sum quoted in Price Centre "B" per day of delay for the Key date
KD-4B	Definitive Design Submission for Permanent Structures including Architectural and Structural for complete station	518	0.005% of the fixed lump sum quoted in Price Centre "B" per day of delay for the Key date
KD-5	Base slab construction for the station including installation of waterproofing membrane, toe in of slab (if any) and installation of tension piles (if any)	434	0.025% of the fixed lump sum quoted in Price Centre "B" per day of delay for the Key date
KD-6	Achieve substantial completion of the following station rooms/areas ➤ To Provide access to all Interfacing Contractors of Group 1 station rooms finished to Degree 3 completion ➤ To provide access to Lift & Escalator Contractor on Station entrance and structure on Concourse and Mezzanine (wherever	672	0.025% of the fixed lump sum quoted in Price Centre "B" per day of delay for the Key date

Key Dates	Description	Number of days from Commencement	Delay Damages for non-achieving the Key Dates
	applicable) Level finished to Degree 2 completion ➤ All tunnel ventilation shafts		
KD-7	Achieve substantial completion of station public Concourse/Mezzanine (wherever applicable) Level areas including all entrances finished to Degree 2 completion and provide access to all Interfacing Contractors	735	0.01% of the fixed lump sum quoted in Price Centre “B” per day of delay for the Key date
KD-8	Achieve substantial completion of station track areas finished to Degree 1 completion and provide access to interfacing contractors	791	0.01% of the fixed lump sum quoted in Price Centre “B” per day of delay for the Key date
KD-9	Achieve substantial completion of station structures on Platform Level finished to Degree 2 completion and provide access to Lift & Escalator Contractor	847	0.01% of the fixed lump sum quoted in Price Centre “B” per day of delay for the Key date
KD-10	Achieve substantial completion of the following station rooms / areas and provide access to all Interfacing Contractors ➤ Group 1 station rooms in the ancillary buildings on Street Level to finished Degree 3 completion Platform screen door work zones to finished Degree 2 completion	903	0.01% of the fixed lump sum quoted in Price Centre “B” per day of delay for the Key date
KD-11	Achieve substantial completion of station Platform Level areas finished to Degree 2 completion and provide access to all Interfacing contractors	945	0.01% of the fixed lump sum quoted in Price Centre “B” per day of delay for the Key date
KD-12	Achieve substantial completion of the following station rooms after removal of TBM working shaft (wherever provided in	1092	0.01% of the fixed lump sum quoted in Price Centre “B” per day of delay for the Key date

Key Dates	Description	Number of days from Commencement	Delay Damages for non-achieving the Key Dates
	station areas) and provide access to all Interfacing Contractors Group 1 station rooms on Concourse/Mezzanine (wherever applicable) Level finished to Degree 3 completion		
KD-13	Achieve substantial completion of the following station rooms and public Concourse/Mezzanine (wherever applicable) Level areas and provide access to AFC Contractor Groups 2a and 2b station rooms and areas on Concourse/Mezzanine (wherever applicable) Level finished to Degree 3 completion	1008	0.01% of the fixed lump sum quoted in Price Centre “B” per day of delay for the Key date
KD-14	Achieve substantial completion of all E&M works (including DG set & UPS) to permit permanent power on to all stations and Complete all architectural finishing and signage works in all respects	1183	0.01% of the fixed lump sum quoted in Price Centre “B” per day of delay for the Key date
KD-15	Achieve issuance of Taking Over Certificate (all completed to degree 4 completion)	1270	0.05% of the fixed lump sum quoted in Price Centre “B” per day of delay for the Key date

Key Dates: Mandai Station

Key Dates	Description	Number of days from Commencement	Delay Damages for non-achieving the Key Dates
KD-1	Design Co-ordination and site investigations submission	140	0.025% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date
KD-2	Preliminary Design Submission	182	0.025% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date
KD-3	Completion Excavation for station box	308	0.025% of the fixed lump sum quoted in Price Centre “C” per

Key Dates	Description	Number of days from Commencement	Delay Damages for non-achieving the Key Dates
			day of delay for the Key date
KD-4A	Definitive Design Submission for Permanent Structures including Architectural and Structural for base slab	336	0.005% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date
KD-4B	Definitive Design Submission for Permanent Structures including Architectural and Structural for complete station	518	0.005% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date
KD-5	Base slab construction for the station including installation of waterproofing membrane, toe in of slab (if any) and installation of tension piles (if any)	434	0.025% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date
KD-6	<p>Achieve substantial completion of the following station rooms/areas</p> <ul style="list-style-type: none"> ➤ To Provide access to all Interfacing Contractors of Group 1 station rooms finished to Degree 3 completion ➤ To provide access to Lift & Escalator Contractor on Station entrance and structure on Concourse and Mezzanine (wherever applicable) Level finished to Degree 2 completion ➤ All tunnel ventilation shafts 	672	0.025% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date
KD-7	Achieve substantial completion of station public Concourse/Mezzanine (wherever applicable) Level areas including and all entrances finished to Degree 2 completion and provide access to all Interfacing Contractors	735	0.01% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date
KD-8	Achieve substantial completion of station track areas finished to Degree 1 completion and provide access to interfacing contractors	791	0.01% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date

Key Dates	Description	Number of days from Commencement	Delay Damages for non-achieving the Key Dates
KD-9	Achieve substantial completion of station structures on Platform Level finished to Degree 2 completion and provide access to Lift & Escalator Contractor	847	0.01% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date
KD-10	Achieve substantial completion of the following station rooms / areas and provide access to all Interfacing Contractors ➤ Group 1 station rooms in the ancillary buildings on Street Level to finished Degree 3 completion Platform screen door work zones to finished Degree 2 completion	903	0.01% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date
KD-11	Achieve substantial completion of station Platform Level areas finished to Degree 2 completion and provide access to all Interfacing contractors	945	0.01% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date
KD-12	Achieve substantial completion of the following station rooms after removal of TBM working shaft (wherever provided in station areas) and provide access to all Interfacing Contractors Group 1 station rooms on Concourse/Mezzanine (wherever applicable) Level finished to Degree 3 completion	1092	0.01% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date
KD-13	Achieve substantial completion of the following station rooms and public Concourse/Mezzanine (wherever applicable) Level areas and provide access to AFC Contractor	1008	0.01% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date

Key Dates	Description	Number of days from Commencement	Delay Damages for non-achieving the Key Dates
	Groups 2a and 2b station rooms and areas on Concourse/Mezzanine (wherever applicable) Level finished to Degree 3 completion		
KD-14	Achieve substantial completion of all E&M works (including DG set & UPS) to permit permanent power on to all stations and Complete all architectural finishing and signage works in all respects	1183	0.01% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date
KD-15	Achieve issuance of Taking Over Certificate (all completed to degree 4 completion)	1270	0.05% of the fixed lump sum quoted in Price Centre “C” per day of delay for the Key date

Key Dates : Swargate Station

Key Dates	Description	Number of days from Commencement	Delay Damages for non-achieving the Key Dates
KD-1	Design Co-ordination and site investigations submission	140	0.025% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date
KD-2	Preliminary Design Submission for Permanent Structures including Architectural and Structural for station box	182	0.025% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date
KD-3A	Definitive Design Submission for Permanent Structures including Architectural and Structural for base slab	336	0.005% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date
KD-3B	Definitive Design Submission for Permanent Structures including Architectural and Structural for complete station	518	0.005% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date
KD-4	Base slab construction for the station including installation of waterproofing membrane, toe in of slab (if any) and	434	0.025% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date

Key Dates	Description	Number of days from Commencement	Delay Damages for non-achieving the Key Dates
	installation of tension piles (if any)		
KD-5	<p>Achieve substantial completion of the following station rooms/areas</p> <ul style="list-style-type: none"> ➤ To Provide access to all Interfacing Contractors of Group 1 station rooms finished to Degree 3 completion ➤ To provide access to Lift & Escalator Contractor on Station entrance and structure on Concourse and Mezzanine (wherever applicable) Level finished to Degree 2 completion ➤ All tunnel ventilation shafts 	672	0.01% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date
KD-6	Achieve substantial completion of station public Concourse/Mezzanine (wherever applicable) Level areas including entrances finished to Degree 2 completion and provide access to all Interfacing Contractors	735	0.01% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date
KD-7	Achieve substantial completion of station track areas finished to Degree 1 completion and provide access to interfacing contractors	791	0.01% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date
KD-8	Achieve substantial completion of station structures on Platform Level finished to Degree 2 completion and provide access to Lift & Escalator Contractor	847	0.01% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date
KD-9	<p>Achieve substantial completion of the following station rooms / areas and provide access to all Interfacing Contractors</p> <ul style="list-style-type: none"> ➤ Group 1 station rooms in the ancillary buildings on Street Level to finished Degree 3 completion Platform screen door work zones to finished Degree 2 completion 	903	0.01% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date
KD-10	Achieve substantial completion of station Platform Level areas finished to Degree 2 completion	945	0.01% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date

Key Dates	Description	Number of days from Commencement	Delay Damages for non-achieving the Key Dates
	and provide access to all Interfacing contractors		
KD-11	Achieve substantial completion of the following station rooms after removal of TBM working shaft (wherever provided in station areas) and provide access to all Interfacing Contractors Group 1 station rooms on Concourse/Mezzanine (wherever applicable) Level finished to Degree 3 completion	945	0.01% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date
KD-12	Achieve substantial completion of the following station rooms and public Concourse/Mezzanine (wherever applicable) Level areas and provide access to AFC Contractor Groups 2a and 2b station rooms and areas on Concourse/Mezzanine (wherever applicable) Level finished to Degree 3 completion	1008	0.01% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date
KD-13	Achieve substantial completion of all E&M works (including DG set & UPS) to permit permanent power on to all stations and Complete all architectural finishing and signage works in all respects	1183	0.05% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date
KD-14	Achieve issuance of Taking Over Certificate (all completed to degree 4 completion)	1270	0.05% of the fixed lump sum quoted in Price Centre “D” per day of delay for the Key date

Tunnel Key Dates

Key Dates	Description	Number of days from Commencement	Delay Damages for non-achieving the Key Dates
KD-1	Preliminary Design Submission and Finalization of TBM design and proceed for manufacturing	63	0.025% of the fixed lump sum quoted in Price Centre “E,F & G” per day of delay for the Key date
KD-2	Design Co-ordination and site investigations submission	140	0.025% of the fixed lump sum quoted in Price Centre “E,F & G” per day of delay for the Key date
KD-3	Submission of Definitive Design	181	0.025% of the fixed lump sum quoted in Price Centre “E,F & G” per day of delay for the Key date
KD-4	Completion of casting yard and first segment	224	0.025% of the fixed lump sum quoted in Price Centre “B,C,D,E,F & G” per day of delay for the Key date
KD-5	Assembling and Start of Initial drive for TBM-1	364	0.025% of the fixed lump sum quoted in Price Centre “E” per day of delay for the Key date
KD-6	Assembling and Start of Initial drive for TBM-2	392	0.025 % of the fixed lump sum quoted in Price Centre “E” per day of delay for the Key date
KD-7A	TBM 1 Arrival at Mandai Station (Drive Swargate to Mandai)	679	0.005 % of the fixed lump sum quoted in Price Centre “E” per day of delay for the Key date
KD-7B	TBM 2 Arrival at Mandai Station (Drive Swargate to Mandai)	714	0.005 % of the fixed lump sum quoted in Price Centre “E” per day of delay for the Key date
KD-8A	TBM 1 Arrival at Budhwar Peth Station (Drive Mandai to Budhwar Peth)	1001	0.05 % of the fixed lump sum quoted in Price Centre “D & E” per day of delay for the Key date
KD-8B	TBM 2 Arrival at Budhwar Peth Station (Drive Mandai to Budhwar Peth)	1036	0.05 % of the fixed lump sum quoted in Price Centre “E” per day of delay for the Key date
KD-9	Achieve substantial completion of all bored tunnels (including cross passages and stabling lines at the back of Swargate station) finished to Degree 1 completion and provide access to Track work and other Interfacing Contractors on entire bored tunnels (all bored	1064	0.025 % of the fixed lump sum quoted in Price Centre “E” per day of delay for the Key date

Key Dates	Description	Number of days from Commencement	Delay Damages for non-achieving the Key Dates
	tunnel lengths)		
KD- 10	Achieve substantial completion of cross passages and provide access to Interfacing Contractors	1183	0.025 % of the fixed lump sum quoted in Price Centre “E, F & G” per day of delay for the Key date
KD-11	Achieve substantial completion of track areas for turn- out areas finished to Degree 1 completion and provide access to Track work and other Interfacing Contractors	1183	0.025 % of the fixed lump sum quoted in Price Centre “E, F & G” per day of delay for the Key date
KD-12	Achieve substantial completion of all E&M works (including DG set & UPS) to permit permanent power on to all tunnels and complete all works in all respects	1183	0.05 % of the fixed lump sum quoted in Price Centre “E, F & G” per day of delay for the Key date
KD-13	Achieve issuance of taking over certificate(all completed to degree 4 completion)	1270	0.05 % of the fixed lump sum quoted in Price Centre “E, F & G” per day of delay for the Key date

Notes to Key Dates:

1. The achievement of Key Date shall be subject to the issuing of a notice of no objection from the Engineer.
2. The achievement of a Degree of Completion shall require the completion of works for that particular Degree of Completion and all preceding ones.
3. The Degree of Completion shall be read in conjunction with the Interface Specifications (interface related Contract requirements and Stipulations) to establish access requirements for Interfacing Contractors.
4. The access and order for completion of the work specified within each Key Date and within each Degree of Completion shall be coordinated among the Interfacing Contractors in the development of the Coordinated Installation Programme (CIP) and Track Related Installation Programme (TRIP).

Degree of Completion for Station Rooms (Including those on Platform, tunnel (s) and cross-passages in NATM Stations)

Degree 1	Degree 2	Degree 3	Degree 4
<ul style="list-style-type: none"> • Structure complete, clean, dry and all works area to be watertight and weatherproof • Cast-in and concealed components complete • Movement and expansion joints installed • Partition walls complete with penetrations and plant delivery openings formed • Plant plinths complete and survey accepted • Complete floor screed • Complete permanent framing for doors, hatches, and other openings • Complete wall plastering and all finishing works for wall prior to painting • Drainage system and discharge connection complete • Complete sealant for ceiling and floor • Complete air and services ducts 	<ul style="list-style-type: none"> • Complete fixing brackets for pedestal for raised floor • Earthing and bonding complete • Contractor's Equipment removed • Temporary power and lighting available • Suitable work and storage areas available for Interfacing Contractors • Lifting facilities installed and certified • Clear route available for plant access and equipment delivery • Survey reference lines available • Complete TVS shafts 	<ul style="list-style-type: none"> • Complete wall painting • Complete all cable containment leading to, and inside the equipment rooms • Complete all cable riser / shafts • Complete all E & M services except final fittings • Complete wall, raised floor and false flooring in SER/CER and SCR / floor finishes, and ceiling / false ceiling, except for locations where these works have to be completed after completion of works by the Interfacing Contractors • Complete all internal glazing • Temporary doors with locks installed • Temporary air-conditioning / ventilation available • Openings and service penetrations temporarily blanked off 	<ul style="list-style-type: none"> • Complete all electrical and light fittings • Complete all fire protection and detectors • Louvres and grilles installed • All finishes including signage complete • Permanent LV including UPS supply available • Permanent doors and ironmongery installed • Complete all works including testing and commissioning

Group 1	
Signal Equipment Room (SER)	Signaling Control Panel Room
Communication Equipment Rooms (CER)	Telecommunication Closet
33kV MV Switchgear Room	33/0.415kV Transformer Room (ASS)
Any Power Supply or Traction related rooms/facilities	
Platform Screen Door related rooms (if required)	Station Control Room (SCR)
Tunnel Ventilation Machine Rooms	Ventilation and Air Conditioning Mechanical Rooms
Chiller Plant Room	
Group 2a	
Ticket Office (TO)	
Excess Fare Office	Other Rooms

Note: Interfacing Contractors installation and access requirements shall be agreed during interface coordination meetings and in accordance with Appendix 19 of this Section VI, Part 2.

Degree of Completion for Tunnels (Other than Tunnel (s) in NATM Stations)

Degree 1	Degree 2	Degree 3	Degree 4
<ul style="list-style-type: none"> • Tunnel structure complete, clean, dry and watertight • Trackbed concrete (including shear connectors), walkway, cable trough / duct complete and surveyed. As-built records on track centre line level and alignment available • Complete all trackside cable containment, cable supports, and all mounting facilities for Interfacing Contractors • Earthing and bonding connections complete • Drainage system and discharge connection complete with temporary pumps • Temporary tunnel ventilation, background lighting, power, and water, available for Interfacing Contractors • Clear routes available for plant access • Lifting facilities installed and certified • Permanent cross-passage and door installed • Contractor's Equipment removed • All provisions stipulated in the Interface Specification (interface related Contract requirements and Stipulations) required for access by Trackworks Contractor available 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Permanent cross- passage doors ironmongery installed • All graphics and signage complete • Permanent Power system including Uninterruptible Power Supply (UPS) system complete • Permanent Tunnel Lighting system complete • Permanent E&M system complete • Energisation of main LV switchboards complete and permanent LV supply available • Permanent pumps installed and commissioned 	<ul style="list-style-type: none"> • Complete all works including testing and commissioning

Degree of Completion for Station Track Area

Degree 1	Degree 2	Degree 3	Degree 4
<ul style="list-style-type: none"> • Complete station structures for the track, including all ductings, ventilation shafts, plenums, nozzles, and other fixtures above, under and adjacent to the track • Complete waterproofing for the station track structure • Joint sealants complete • Track bed, walkway, derailment curb complete and survey accepted • Complete all trackside cable containments and mounting facilities for Interfacing Contractors • Earthing and bonding connections complete and test results accepted • Advertising panel brackets installed • Drainage system and discharge connection complete and operational with temporary pumps • Temporary ventilation, background lighting, power, and water, available for Interfacing Contractors • Clear routes available for plant access, equipment and track concrete delivery 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • All cabling and wiring complete • Graphics, advertising panels and signages installed • Permanent Lighting systems commissioned • Permanent E & M systems complete • Permanent pumps commissioned • Complete all permanent fixtures • All openings and service penetrations sealed 	<ul style="list-style-type: none"> • All works including testing and commissioning complete

Degree of Completion for Platform Screen Door Work Zone (area within 3m from platform edge)

Degree 1	Degree 2	Degree 3	Degree 4
<ul style="list-style-type: none"> • Structure complete, clean, dry and all works area to be weatherproof • Cast-in and concealed components complete • Movement and expansion joints installed • Partition walls complete with penetrations and plant delivery openings formed 	<ul style="list-style-type: none"> • Earthing and bonding complete and tested accepted • Contractor's Equipment removed • Temporary power and lighting available • Suitable work and storage areas available for Interfacing Contractors • Header I-beam and works on threshold complete with survey accepted • Clear plant access and delivery routes available 	<ul style="list-style-type: none"> • Complete installation and testing of insulation membrane 	<ul style="list-style-type: none"> • Complete all wall, ceiling / false ceiling and floor finishes • Complete all E & M services • Complete all fire protection and detectors • Louvres and grilles installed • All finishes including signage complete • Permanent LV supply available • All openings and service penetrations sealed • Complete all works including testing and commissioning

Degree of Completion for Station Concourse/Mezzanine (wherever applicable) and Platform Areas, including Entrances (excluding PSD Work Zones)

Degree 1	Degree 2	Degree 3	Degree 4
<ul style="list-style-type: none"> • Structure complete, clean, dry and all works area to be watertight and weatherproof • Cast-in and concealed components complete • Movement and expansion joints installed • Partition walls complete with penetrations and plant delivery openings formed • Complete floor screed • Drainage system and discharge connection complete • Complete permanent framing for doors, hatches, and other openings 	<ul style="list-style-type: none"> • Complete all cable containment in concourse and platform area for Interfacing Contractors including connection to trackside • Earthing and bonding complete • Contractor's Equipment removed • Temporary power and lighting available • Suitable work and storage areas available for Interfacing Contractors • Clear route available for plant access and delivery • Survey reference lines available • Complete mounting bracket, primary ceiling support frame, power and data points for Interfacing Contractors 	<ul style="list-style-type: none"> • Complete all wall, ceiling / false ceiling and floor finishes, except for locations where the works have to be carried out after the completion of works by Interfacing Contractors • Joinery/framing/ counter for supporting AFC Contractor's equipment available 	<ul style="list-style-type: none"> • Complete all electrical and light fittings • Complete all fire protection and detectors • Louvres and grilles installed • All finishes including signage complete • Permanent LV supply including UPS available • All openings and service penetrations sealed • Complete all works including testing and commissioning

Group 2b

Ticket Hall (paid and unpaid areas)

Degree of Completion for Lifts & Escalators

(a) Lift Shafts

Degree 1	Degree 2	Degree 3	Degree 4
<ul style="list-style-type: none"> • Structure complete, clean, dry and all works area to be watertight and weatherproof • Cast-in and concealed components complete • Openings to lift machine room and lift shaft available • Partition walls complete with penetrations and plant delivery openings formed • Plant plinths complete and survey accepted • Drainage system and discharge connection complete • Complete floor screeding 	<ul style="list-style-type: none"> • Earthing and bonding complete • Contractor's Equipment removed • Temporary power and lighting available • Suitable work and storage areas available for Interfacing Contractors • Lifting facilities installed and certified • Clear routes available for plant access and delivery • Survey reference lines available • Shaft alignment, location of penetrations and openings surveyed and accepted • Complete builder's works provisions for buffers area • Complete structural frames and associated fixtures for lift shafts • Provide temporary safety barrier at landing, lift shaft and other openings 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Complete all wall, ceiling and floor finishes including signages • Complete all electrical and light fittings • Complete all fire protection and detectors • All finishes including signage complete • All openings and service penetrations sealed • Complete all works including testing and commissioning

Escalator Zones

Degree 1	Degree 2	Degree 3	Degree 4
<ul style="list-style-type: none"> Escalator pits complete, clean, dry and watertight Cast-in and concealed components complete Plant plinths complete and survey accepted Drainage system and discharge connection complete Complete permanent framings for doors, hatches and other openings 	<ul style="list-style-type: none"> Earthing and bonding complete Contractor's Equipment removed Temporary power and lighting available Suitable work and storage areas available for Interfacing Contractors Lifting facilities for escalator installed and certified Clear routes available for plant access and delivery Survey reference lines available Alignment (vertical and horizontal) and recess supports, including intermediate supports surveyed and accepted Provide temporary safety barrier at landing and other openings 	<ul style="list-style-type: none"> Complete cable containment and fire protection within the escalator structure Complete installation of isolators / distribution boards 	<ul style="list-style-type: none"> Complete all wall, ceiling and floor finishes Complete all electrical and light fittings Complete all fire protection and detectors Louvres and grilles installed All finishes including signage complete Permanent LV supply available All openings and service penetrations sealed Complete floor finishes at landings Complete balustrade and barrier around the escalator voids Complete all works including testing and commissioning

Group – Lifts and Escalators

Escalator Zone

Lift Shaft

Maha Metro



Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 3 – Project Calendar

June 2018

PROJECT CALENDAR

- (1) The Project Week shall commence on a Monday. A day shall be deemed to commence at 0001 hour on the morning of the day in question. Where reference is made to the completion of an activity or Milestone by a particular week, this shall mean by midnight on the Sunday of that week.
- (2) Requirements for the computation of Key Dates are given in Appendix 2B to the Employer's Requirements.
- (3) A 7 day week calendar shall be adopted for various (Work) programme schedules for scheduling purposes. Any non-work restriction shall be deemed to have been taken into account in the calendar to plan and programme the Works.
- (4) For Project purposes, the presentation shall be in 'Week'" units.

Maha Metro



Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 4 – Programme Requirement

June 2018

PROGRAMME REQUIREMENTS

1. GENERAL

(1) Purpose of Programme

There are two primary purposes for the requirement of Programme (Scheduling) information described in this document:

- a. Evaluation of Tender
- b. Progress Status Reports during Construction

To provide the Engineer with progress status reports for managing, monitoring and coordinating the awarded contracts during their execution within the overall multi-contract project schedule.

The requirements are organized in two stages. The first stage is a requirement for all Tenderers and shall be submitted as part of Tender. The second stage is a requirement of the Employer and describes a series of reports to be submitted by the Contractor to the Engineer during the execution of the contract, following the award of Contract.

- (2) The Tenderer/ Contractor shall programme his work at all times to meet the Key Dates and the Works Areas Access Dates stated in Appendices 2A and 2B to the Employer's Requirements, and the specified interface periods for the design and installation of the Works with those of the Interfacing Contractors. The Tenderer/ Contractor shall during the progress of the Works constantly monitor his progress against the programmes described below.
- (3) The Tenderer/ Contractor shall include in all programmes his work obligations towards shared access, shared site areas and other coincident or adjacent work areas with regard to all interfacing parties.
- (4) The Works Programme, and all more detailed or revised versions, shall be submitted to the Engineer for his Notice in accordance with the provisions of the Conditions of Contract.

2. METHODOLOGY

- (1) The computerized Critical Path Method (CPM) network using the Precedence Diagramming Method (PDM), has been selected by the Employer as the technique for contract management system and in co-ordinating the multi-contract project. This technique shall also be employed by the Tenderer in preparing their Tender submissions and by the Contractor in their Construction Stage submissions.
- (2) Unless otherwise agreed by the Engineer, all programmes submitted by the Contractor shall be produced using computerized Critical Path Method (CPM) Networks developed implementing the Precedence Diagramming Method (PDM) with Cost Loaded Charts and Tables, using the required software stated in Clause 3 below.
- (3) The Contractor shall implement and use throughout the duration of the Contract, a computerized system to plan, execute, maintain and manage the planning, design, pre-construction, construction, and sub-contracts in executing the CPM scheduling by PDM. The reports, documents and data provided shall be an accurate representation of the current status of the Works and of the work

remaining to be accomplished; shall provide a sound basis for identifying problems, deviations from the planned works, and for making decisions; and shall enable timely preparation of the same for presentation to the Engineer.

3. PROGRAMME MANAGEMENT SOFTWARE

CPM programming software used shall be Primavera Project Planning (P7) Program or latest version. Scheduling software and relevant instruction manuals, licensed for use in connection with the contract, shall be provided by the Contractor according to the Employer's Requirements, Contract Outline Design and Construction Specifications and other contract stipulations. The Contractor shall supply the Engineer with an original licensed copy, including manuals and approved training of the software and any subsequent versions thereof at no extra cost.

4. POST CONTRACT AWARD

- 4.1 The Contractor shall develop his Tender Programme into the Initial Works Programme including an outline Narrative Statement and submit within 4 weeks of the date of commencement and a more detailed version within 7 weeks of receiving the Engineer's notice of no objection to the proposed Initial Works Programme. Refer Clause 6.0.
- 4.2 The first Three Month Rolling Programme shall be submitted within 4 weeks of the date of Commencement and all subsequent editions shall accompany the Monthly Progress Report. The Monthly Progress Reports shall also include a Programme Update as described below. These programmes shall subsequently be updated as described below. Refer Clause 8.0 & 9.0.
- 4.3 Following the Contractor's Initial Works Programme submission but in any case no later than 21 weeks from the date of commencement of the Contract, the Contractor shall submit a detailed **Works Programme** suitably amended to take into account the programmes of Interfacing Contractors. It is the Contractor's responsibility to ensure timely co-ordination with the Interfacing Contractors to review, revise and finalise his Initial Works Programme so as not to affect the progress of the Works and/or the works of the Interfacing Contractors. The resubmitted Works Programme when given a Notice by the Engineer shall form the **Baseline Programme** which shall solely be used for monitoring and evaluating all facets of the Contractor's performance including, but not limited to, actual progress and the effects of variations and delays. The Contractor shall monitor his own performance against the Baseline Programme on a weekly basis and shall prepare and submit to the Engineer written and computerised monthly reports including all supporting data. As the work progresses, it may be necessary to update/ revise the Baseline programme, but such updating shall only be carried out with the prior consent of the Engineer or when directed by them.
- 4.4 For the Initial & Detailed Works Programme submission, one (1) original and six (6) colour copies, with a softcopy on a CD, each of the following programmes and reports shall be submitted to the Engineer:
 - a) Programme: Baseline CPM Network
 - b) Programme: Baseline Milestone based Cost Activity Schedule
 - c) Baseline Schedule Report
 - d) Narrative Statement

- e) Baseline Physical Progress 'S' curve
 - f) Baseline Resource Charts
- 4.5 The Engineer shall review and comment on the Contractor's programmes and information submitted under this Clause. The Engineer will issue his notice or otherwise of the submissions within 4 weeks.
- 4.6 The Engineer shall require the Contractor to re-submit within 2 weeks if he is of the opinion that the programmes and information submitted by the Contractor is unlikely to meet the Contract key dates.
- 4.7 If in the opinion of the Engineer, any of the Contractor's revised programmes and information submitted under the Works Programme is not acceptable, it shall be construed as a failure of the Contractor to meet a Milestone.
- 4.8 Notwithstanding the above, the Engineer may at any time during the course of the Contract require the Contractor to reproduce the computer-generated Baseline Schedule Report described above to reflect actual activity dates and generate schedules based upon "what if" statements. The initial computer-generated report after receiving the Engineer's notice will serve as the base against which the contract progress will be measured. Any changes to the Report reflected in subsequent Baseline Schedule Reports shall also require the Engineer's consent.
- 4.9 Failure to include any element of work required for performance of the Contract shall not relieve the Contractor from completing all works required under the Contract to achieve the original or any extended key completion date.

5. WORKS PROGRAMME

- (1) The Works Programme shall detail the full scope of the works taking into account the complex nature and different phases of the contract, and shall be accompanied by detailed supporting information to demonstrate through the sequence and duration of the activities that the plans are achievable and realistic and that the works to be undertaken can meet the requirements of the contract.
- (2) The Works Programme shall be a computerised Critical Path Method (CPM) network developed using the Precedence Diagramming Method (PDM) and shall be present in bar chart and time-scaled network diagram format to a weekly or monthly time scale.
- (3) Tasks in the Works Programme shall be sufficiently detailed to describe activities and events that include, but are not limited to, the following:
 - (a) Key Dates, Works Areas Access Dates, any interface and handover dates
 - (b) All physical work to be undertaken in the performance of the Contract obligations, including Temporary Works
 - (c) The requested date for issue of any drawings or information by the Engineer
 - (d) Incorporation of principal aspects of the Design Programme and Design Submission Programme, including achievement of Preliminary Design, Definitive design and Construction Reference Drawings.
 - (e) Due time allowance for review by the Engineer of the Contractor's submissions, as well as the subsequent amendment and re-submission by the Contractor in the design review and comment process,

- (e) Due time allowance for complying with requirements of all Government Departments and all others whose consent, permissions, authority or licence is required prior to the execution of any work.
- (f) Order, procurement, manufacture, delivery, testing and installation of major materials and the delivery and/or partial delivery date on-Site of principal items of Contractor's Equipment.
- (g) Any off-site work such as production or pre-fabrication of components
- (h) Installation of temporary construction facilities
- (i) Interface periods with the Interfacing Contractors or utility undertakings
- (j) Design, supply and/or construction activities of sub-contractors
- (k) Testing, commissioning and integrated testing of the Works.
- (l) Any outside influence which will or may affect the Project.
- (m) Mobilization and demobilization
- (n) Weather allowance
- (o) Completion of core areas / rooms for access by interfacing parties.
- (4) The Works Programme shall show achievement of all Key Dates. The programme shall also show Milestones, but the Milestones shall not be taken as imposing any constraints that in any way affect the logic or limit any other dates in the programme.
- (5) Activity descriptions shall be unique, describing discrete elements of work. Any activity creating an imposed time or other constraint shall be fully defined by the Contractor.
- (6) The Works Programme shall be organised in a logical work-breakdown-structure including work stages and phases, and shall clearly indicate the critical path(s). Each activity in the Works Programme shall be coded to indicate:
 - (a) Activity ID and Activity Code, the structure of which should be agreed with the Engineer.
 - (b) The Engineer may request additional activity coding to the extent available without restraint to the Contractor's utilisation of the programme software. When requested, the Contractor shall add the required additional coding to the Programme. The Contractor shall use additional code fields as requested to comply with the requirements and for the use of the Contractor.
- (7) Activity duration shall not exceed two (2) weeks, unless otherwise consented to by the Engineer, except non-construction activities such as submittals, submittal reviews, procurement and delivery of materials or equipment and concrete curing. The Contractor shall submit a Programme/Project Calendar cross reference clearly indicating the allowance for holidays.
- (8) The Works Programme, in each submission, shall be accompanied by an Activity Report and a Narrative Statement as described below in both electronic and hard copy format (time scale logic diagrams in A1 size, reports in A4 size).
- (9) Activity Report

Shall list all activities, and events in the Works Programme, sorted by activity identification number.

The Activity Report shall include the following for each activity and event:

- (a) Activity identification number and description,
- (b) Duration expressed in Days,
- (c) Early and late start & early and late finish dates. Planned start and finish dates,
- (d) Calculated total float and free float,
- (e) Predecessor and successor(s), accompanying relationships and lead/lag duration,
- (f) Imposed time or date constraints,
- (g) Calendar.

(10) Narrative

The Narrative shall be a comprehensive statement of the Contractor's plan and approach for the execution of the Works and the achievement of key dates, handover dates, submission dates and any intermediate dates. It shall incorporate outline method statements in respect of major items of work including construction sequences and primary items of plant, Construction Equipment, Temporary Works and the like. It shall fully explain the reasons for the main logic links in the Programme and include particulars of how activity durations are established. This shall include estimated quantities, production rates, hours per shift, work days per week and a listing of the major items of Construction Equipment planned for use on the project. Activities, which may be expedited by use of overtime or additional shifts, shall be identified and explained. A listing of holidays, and other special non-work days being used for the computer reports shall be included.

Supporting information and an accompanying narrative for the Programme that details the basis and assumptions upon which the programme has been drawn shall be prepared and submitted as detailed (but not limited to) below:

- i. A narrative description of the sequence of all sections of the Works and in particular a detailed identification and description of the critical path activities. The narrative shall be supported by sketches illustrating the planning sequences of construction phase of works;
- ii. Marked up plans detailing the concreting and concrete pour dates for major section of each part of the structure;
- iii. An overall manpower forecast detailing individual trades and other sub-contract / indirect labour, commissioning teams in terms of the daily number of workers planned to be engaged. The formats for these forecasts shall be in accordance with the Engineer's requirements;
- iv. Typical cycle time analysis;
- v. Planned production outputs for all major activities and areas of Works;
- vi. List of major items of plant and equipment that are required to be procured identifying the required lead times;
- vii. Accumulative curves and histograms showing the planned weekly figures for each principal quantity, major item of equipment and major power

trades;

- viii. Any programme constraints, giving details of the constraints and substantiation thereto;
- ix. Total float listing in order of total float;
- x. Daily and weekly working hours, holidays and shift patterns;
- xi. Other information that the Engineer may request;

(11) Physical Progress 'S' Curve

The Contractor shall also submit at the end of every month, for inclusion in the Monthly Progress Report as stated in Appendix 5, a forecast Cumulative Physical Progress 'S' curve based on the time-phased distribution of cost in the CPM Network Logic Diagram, expressed in percentage terms and plotted with the early and late dates. This 'S' curve shall be generated from the computerised CPM Network Logic Diagram.

(12) Resources

The Contractor shall provide on the submission of the Baseline programme full resource details for major activities including but not limited to the substructure, superstructure, architectural and building services fit out stages of the works. These shall include

- Major manpower trades
- Number of items of major plant and equipment
- Principal quantities (i.e., volume of excavation, volume of concrete, tonnage of steel work / reinforcement, area of formwork, length of pipe work, area of internal partition walls of finishes / cladding for floor walls, ceiling and roof etc.)
- Other details as appropriate or required by the Engineer.

The Contractor shall also Resource Charts, generated from the Contractor's CPM Network Diagram, showing the anticipated manpower and main Construction Equipment usage during the execution of the Project.

As an additional monitoring facility, indicator resources shall be assigned to relevant activities for the major items of work. Indicator resources shall be directly allocated for excavation (cu.m.), piling (no.), diaphragm walling (m.), concrete (cu.m.), tunnel lining (m), etc. Resource indicators may be input as a daily rate, expected required rate, or as an activity total in the relevant units. These are purely indicative quantities and do not form part of contract.

- (13) All submissions of proposed Works Programmes subsequently, after approval of the Initial Works Programme, shall include the actual physical progress of work and forecast of the remaining work. Actual progress shall be stated in percent complete, remaining duration, and actual start and finish dates for each activity in the Works Programme.

6. INITIAL WORKS PROGRAMME

- (1) The Initial Works Programme submitted as under Clause 4.1 need not include the full details given under Clause 5 above. It should be a condensed version with combined activities of longer duration but must show clearly how the requirements of the Contract are to be achieved. The outline Narrative Statement shall be in sufficient detail to clearly show the Contractor's

intention.

- (2) Within 7 weeks of the Engineer's consent to the Initial Works Programme, the Contractor shall submit to the Engineer an expanded and more detailed version of the Initial Works Programme containing all of the information and detail required under Clause 5 above.
- (3) Such submission shall make use of the Tender Programme submitted earlier but refined to include the best estimates of dates for the work of Interfacing Contracts which has impact on the Contractor's programme. Such programmes shall be amended subsequently to incorporate the actual dates/schedule of the affecting contracts. It is the Contractor's responsibility to ensure timely co-ordination with the Interfacing Contractors to finalise the Initial Programme, without affecting progress of the work.

7. WORKS PROGRAMME REVISIONS

- (1) The Contractor shall immediately notify the Engineer in writing of the need for any changes in the Works Programme, whether due to a change of intention or of circumstances or for any other reason. Where such proposed change affects timely completion of the Works or any other Key Date the Contractor shall within fourteen (14) days of the date of notifying the Engineer submit for the Engineer's notice its proposed revised Works Programme and accompanying Narrative Statement. The proposed revised Works Programme shall show the sequence of operations of any and all works related to the change and the impact of changed work or changed conditions.
- (2) If at any time the Engineer considers the actual or anticipated progress of the work reflects a significant deviation from the Works Programme, he may request the Contractor to submit a proposed revised Programme which together with an accompanying Activity Report and Narrative Statement, shall be submitted by the Contractor within fourteen (14) days after the Engineer's instruction. The proposed revised Works Programme shall show the sequence of operations of any and all work related to the change and the impact of changed work or changed conditions.
- (3) All activities that have negative float must be analysed by the Contractor to identify the impact on the timely completion of the Works or on the achievement of Key Dates.

8. THREE MONTH ROLLING PROGRAMME

- (1) The Three Month Rolling Programme shall be an expansion of the current Works Programme showing the activities completed in the last month and the activities that are in progress or will start within the next three (3) months. The Three Month Rolling Programme shall provide more detail of the Contractor's plan, organisation and execution of the work within these periods. The Contractor shall expand each activity planned to occur during the next three (3) month period, if necessary, to a daily level of detail.
- (2) The Three Month Rolling Programme shall be developed as a Critical Path Method (CPM) network, and shall be presented in bar chart and time-scaled network diagram format. Bar charts shall be presented on A4 sheets and time-scaled networks diagrams A1 size. Tasks in the programme shall be

derivatives of and directly related to tasks in the approved Works Programme. One (1) original and six (6) colour copies, with a softcopy on a CD, of the schedule shall be submitted

- (3) The Contractor shall describe the discrete work elements and work element inter-relationships necessary to complete all works and any separable parts thereof including work assigned to sub-contractors.
- (4) Activity duration shall not exceed two (2) weeks unless otherwise consented to by the Engineer.
- (5) Each activity in the Three Month Rolling Programme shall be coded, or described so as clearly to indicate the corresponding activity in the Works Programme.

The three months Rolling Programme shall require the Engineer notice for payment purposes.

9. THREE MONTH ROLLING PROGRAMME REVISIONS AND UPDATE

- (1) The Three Month Rolling Programme shall be a progress update of the accepted Baseline Programme. The Three Month Rolling Programme shall be extended forward each month as described under Clause 8 above. Each submission of the Three Month Rolling Programme shall be accompanied by a Programme Analysis Report, describing actual progress to date, and the forecast for activities occurring over the next three-month period.
- (2) If the Three Month Rolling Programme is at variance with the Works Programme, the Programme Analysis Report shall be accompanied by a supporting Narrative Statement describing the Contractor's plan for the execution of the activities to be undertaken over the three month period, including programme assumptions and methods to be employed in achieving timely completion.

The Contractor shall revise the Three Month Rolling Programme or propose revisions of the Works Programme in accordance with Clause 7, or both, from time to time as may be appropriate to ensure consistency between them.

10. THREE WEEK ROLLING SCHEDULE

- (1) Once a week, on a day mutually agreed to by the Engineer and the Contractor, a meeting will be held to assess progress by the Contractor during the previous work week. The Contractor shall submit a construction schedule listing activities completed and in-progress within the previous week and the activities scheduled for the succeeding three weeks based on the detailed Works Programme. One (1) original and six (6) colour copies, with a softcopy on a CD, of the schedule shall be submitted on A3 sized paper.
- (2) The 3-week rolling programme shall be in bar chart programme format. The activities shown shall be a complete amplification of the activities in the 3-month rolling programme and shall show breakdown of work in sufficient detail and on a room by room / area by area and day to day basis. The 3-week rolling programme shall be a working programme with sufficient data for reporting, monitoring, measuring, and evaluating the Contractor's progress of the Works and manpower deployment to site. All activities shall be referenced back to the 3-month rolling programme through the Activity

ID. Activities that were scheduled to be completed but remain uncompleted shall be captured by the 3-week rolling programme notwithstanding that it may have fallen outside of the 4-week cycle. However, activity bars need not be shown for such activities to retain the 4-week cycle in the activity bar area. The 3-week rolling programme shall be submitted every Monday morning on a weekly basis. The percentage completion shall be agreed by the Engineer.

(3) The first 3-week rolling programme shall be submitted within 2 weeks of the contract commencement date, in colour on A3 paper.

11. PROJECT CALENDAR

For the Project, the Contractor shall adopt 7 days a week calendar, identical calendar for the purpose of programming and execution of Works. Official documents shall be transacted during 5 days week - Monday through Friday, except for National (Govt. of India) Holidays. For Project purposes, a week begins at 0001 hours on a Monday and ends at 2359 hours on a Sunday. The completion of an activity or the achievement of an event when given a week number shall be taken to mean midnight on the Sunday at the end of the numbered week. An access date or activity start date when given as a week number shall be taken to mean 0001 hours on a Monday of the Numbered week.

12. PROGRAMMING PERSONNEL

The Contractor shall submit, as part of its Staff Organisation Plan, the names and experience and any required information for the staff to be employed on Works Programming. The Project Programmer shall be a Professional Engineer with at least ten (10) years' relevant experience in programming of civil works (comprising underground stations and tunnels) of similar scope. The Project Programmer shall be knowledgeable of, and have experience in, preparing programmes (scheduling) with computerized Critical Path Method (CPM) networks using the Precedence Diagramming Method (PDM) with Primavera Project Planning software. Also there shall be. Others in the group shall have at least three (3) years experience in such work. The programmers shall be employed by the Contractor full time on the Contract until the completion or such earlier time the Engineer may give his consent.

13. PROGRAMME AND REPORT SUBMISSION FORMAT

The Contractor shall submit one (1) original and six (6) copies in color, and a softcopy on a CD, of all submissions to the Engineer. All submissions shall be in A0, A1, A3 or A4 size, as appropriate, except as may otherwise be agreed by the Engineer.

14. FAILURE TO SUBMIT PROGRAMME

Failure of the Contractor to submit any programme, or any required revisions thereto within the time limits stated for notice of no objection by the Engineer, shall be sufficient reason for not making the relevant milestone on account payment by the Engineer

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PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 5 – Monthly Progress Report

June 2018

MONTHLY PROGRESS REPORTS

1. GENERAL

- (1) The Contractor shall submit to the Engineer six (6) coloured copies and a soft copy on CD of the Monthly Progress Report. This Report shall be submitted by the last day of each calendar month and shall account for all work actually performed from 26th day of the last month and up to and including the twenty-fifth (25th) day of the month of the submission.
- (2) The Report shall be typed, printed and bound. It shall be supported by graphics and photographs as specified in Clause 9 of this Appendix. It shall be submitted in a format to which the Engineer shall have given his consent. Unless the Engineer directs otherwise, the Contractor's Monthly Report shall contain sections/sub-sections for, but not limited to, the topics described in this Appendix.
- (3) The Contractor shall include in the Monthly Progress Report a record of monthly progress of various major Works on Site in the form of colour photographs with appropriate annotations and dates stated.
- (4) The Contractor shall deliver daily to the Engineer, a report as to the number of workmen, plant and equipment employed on the works in each trade, etc. and a log of delivery notes for all goods and materials delivered to the Site. This information shall be summarised as a monthly return for the monthly progress report

2. FINANCIAL STATUS

- (1) A narrative review of all significant financial matters, and actions proposed or taken in respect to any outstanding matters.
- (2) A spread sheet summarising each activity, the budget, costs incurred during the period, costs to date, costs to go (including potential variations), cost forecast (total of costs to date and costs to go) and cost variance (difference between cost forecast and budget).
- (3) A spread sheet indicating the status of all payments due and made.
- (4) A report on the status of any outstanding claims. The report shall in particular provide interim updated accounts of continuing claims.

3. PHYSICAL PROGRESS

- (1) The introduction shall briefly summarise the progress that has been made during the past month and how the actual progress relates to the planned progress in accordance with the Works Programme.
- (2) It shall describe the status of work performed, significant accomplishments, including critical items and problem areas, corrective actions taken or planned and other pertinent activities, and shall, in particular, address interface issues, problems and resolutions.
- (3) It shall include a simplified representation of progress measured in percentage terms compared with percentage planned as derived from the Works

Programme.

(4) Physical Progress S-Curve

The Physical Progress S-Curve shall be in the form of a graph which compares the actual progress with the planned progress in terms of percentage to show the project performance.

The value of the physical progress achieved shall be assessed as the aggregate of the values of those activities which are separately identified on the Works Programme and which are:

1. in the opinion of the Engineer, wholly completed;
2. in progress, provided that the value attached to each such activity shall be agreed with the Engineer. Notwithstanding any value agreed with the Engineer shown on the S-Curve, the S-Curve shall not be used for the purpose of Progress Payment Claim.

4. PROGRAMME UPDATE

Programme updating shall include:

- (a) the monthly Programme Update which shall be prepared by recording actual activity completion dates and percentage of activities completed up to the twenty- fifth (25th) of the month together with estimates of remaining duration and expected activity completion based on current progress. The Programme Update shall be accompanied by an Activity Report and a Narrative Statement. The Narrative Statement shall explain the basis of the Contractor's submittal:

- (i) Early Work and Baseline Submittals – explains determination of activity duration and describes the Contractor's approach for meeting required Key Dates as specified in the Contract.
- (ii) Updated Detail Programme Submittals – state in narrative the Works actually completed and reflected along Critical Path in terms of days ahead or behind allowable dates. Specific requirements of narrative are:

If the Updated Detailed Works Programme indicates an actual or potential delay to Contract Completion date or Key Dates, identify causes of delays and provide explanation of Work affected and proposed corrective action to meet Key Dates or mitigate potential delays. Identify deviation from previous month's critical path.

Identify by activity number and description, activities in progress and activities scheduled to be completed.

Discuss Variation Order Work Items, if any.

- (b) the Programme Status which shall :

- (i) show Works Programme status up to and including the current report period, display Cumulative progress to date and a forecast of remaining work.
 - (ii) be presented as a bar-chart size A3 and as a time-related logic network diagram on an A1 media, including activity listings;
 - (iii) schedules of all significant activities tabulated in order of earliest starting date showing the following:
3. the actual start dates for activities which have commenced together with the scheduled start date for each activity and the time lapse;

4. the actual completion dates for activities which have finished together with the scheduled finish date for each activity and the time lapse;
5. the forecast and scheduled start dates for activities scheduled;
6. the forecast and scheduled completion dates for activities which have commenced;
7. the percentage completion of each activity started but not completed;
8. the total float of each activity not completed;
9. Any known delays to activities.
- c) The Activity Variance Analysis which shall analyse activities planned to start prior to or during the report period but not started at the end of the report period as well as activities started and/or completed in advance of the Works Programme.
- d) The Resource Chart to show the actual resources mobilized for the works against the baseline figures in the Baseline Resource Charts.

5. KEY DATES STATUS

A report on the status of all Key Dates due to have been achieved during the month and forecasts of achievement of any missed Key dates, and those due in the next month.

6. THREE MONTH ROLLING PROGRAMME

Include a copy of the 3-month Rolling Programme for that reporting period.

7. PLANNING AND CO-ORDINATION

- (1) Details of co-ordination of interface activities started or completed during the month and shall include for internal co-ordination within the Contractor's own multi-disciplinary team as well as external co-ordination with the Engineer, other Interfacing Contractors, authorities and the like;
- (3) A schedule of all submissions and consents/approvals obtained/outstanding;
- (4) Details of design and drawing progress, including design interface coordination, started or completed during the month as related to the Temporary Works, Permanent Works and Shop drawings;
- (5) Updated Drawing Register;
- (6) Details of the progress of off-site activities such as design, production and/or fabrication of any components or materials;
- (7) Corrective actions either taken by or to be taken by the Contractor to maintain completion dates, including details of any changes made or to be made to the Works Programme to achieve this objective;
- (7) Contractor's organisation and resources;
- (8) Details of any other items which the Engineer or the Contractor shall consider to be necessary or desirable from time to time.

8. PROCUREMENT REPORT

- (2) A summary of all significant procurement activities during the month, including action taken to overcome problems, and details of any outstanding actions.

- (3) A report listing major items of plant and materials which will be incorporated into the Works. The items shall be segregated by type as listed in the Specifications and the report should show as a minimum the following activities:
- (a) Purchase order date - scheduled/actual;
 - (b) Manufacturer/supplier and origin;
 - (c) Letter of credit Issued date;
 - (d) Manufacturer/supplier shipment date - scheduled/actual;
 - (e) Method of shipment;
 - (f) Arrival date in India- scheduled/actual;
 - (g) Analysis of any delay happening/anticipated with proposal for corrective measures.

9. PHOTOGRAPHS

Two sets of photographs shall be provided with the Monthly Progress Report in colour and shall be submitted in the following manner and format.

Digital colour photographs shall be 10cm x 15cm (4-inch x 6-inch), glossy prints, mounted in protective clear plastic folders and contained in a lever-arch binder. The electronic files shall also be provided in “.jpg” format on CD-ROM. The photographs and electronic files shall be identified by a brief narrative indicating:

- (a) Contract number
- (b) A unique sequential number based on an agreed drawing numbering system
- (c) Specific location and subject of photograph
- (d) Date and time of photograph

Each month the Contractor shall propose and the Engineer will confirm the number of photographs to be supplied so as to accurately record progress on all parts of the works. The number of photographs shall not be less than 30 per set unless otherwise agreed by the Engineer.

10. SAFETY

A review of all safety aspects during the month including reports on all accidents, actions proposed to prevent further occurrence and safety performance to-date, including results of all audits undertaken during the reporting period.

11. ENVIRONMENTAL

A review of all the environmental issues during the past month to include all monitoring reports, mitigation measures undertaken and activities to control environmental impacts, including results of all audits undertaken during the reporting period.

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PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 6 – Quality Assurance

June 2018

QUALITY ASSURANCE

Quality System Definitions

The following Quality Management System terms are used in these requirements. The definitions given are derived from ISO 9000: 2005, clause 6.

Audit	Systematic, independent and documented process for obtaining audit evidence and evaluating it objectively to determine the extent to which audit criteria are fulfilled Clause under the Conditions of Contract Conformity Fulfilment of a requirement
Design and Development	Set of processes that transform requirements into specified characteristics or into the specification of a product, process or system. These are prepared to support the Quality Plan for a particular element of the Works
Hold Point (H)	A point in time when a notice of permission, consent or No Objection by the Contractor Quality Assurance Team (or that the Employer/Engineer may elect to witness), is required before the Contractor can proceed with an activity
Inspection and Test Plan	Plans specifying the activities required to establish whether conformity is achieved. They identify the responsibilities for executing the activities, the documents controlling them and details requirements for the production of records
Method Statements	Documented procedures, concerning particular aspects of the process, developed to define the manner of production, installation and servicing Nonconformity Non-fulfilment of a requirement
Observation Point (O)	A stage identified on an Inspection and Test Plan where the Employer/Engineer or authorised third parties may observe activities and any associated verification
Procedure	Specified way to carry out an activity or a process
Quality	Degree to which a set of inherent characteristics fulfils requirements
Quality Management System	Management system to direct and control an organization with regard to quality as formally expressed by top management
Quality Plan	Document specifying the procedures and associated resources shall be applied by whom and when to a specific project, product, process or contract Quality Plan shall specify the quality management system of an organization
Requirement	Need or expectation that is stated, generally implied or obligatory
Record	Document stating results achieved or providing evidence of activities performed
Witness Point (W)	A stage in the pre-construction or construction activities in which a party is invited to witness

1. INTRODUCTION

- 1.1 The Contractor shall maintain and implement a Quality Management System that shall remain in effect during the execution of the Works. Contractor's organisation is required to operate a Quality Management System based on International Standard ISO 9001: 2015 for its scope of Works and in compliance with the requirements of the Contract. The Contractor shall submit his Quality Management System documentation for review and Notice to Proceed by the Employer/Engineer as specified in this Section.
- 1.2 ISO 9001: 2015 Certification of the Contractor's organisation is required for this Project. The Employer/ Engineer may consider the alternative use of ISO 9001: 2015 Certification at his discretion. ISO Certification is a requirement of this Project for the Contractor's subcontractors, consultants, sub-consultants, suppliers and Designers. The Contractor however cannot delegate or subcontract the Employer's Quality Assurance Requirements to subcontractors, consultants, sub-consultants or suppliers without the Employer/Engineer written approval.
- 1.3 The Contractor shall implement a Quality Plan that shall incorporate a comprehensive and documented approach to achieve the Project quality requirements that is capable of ensuring that all aspects of the Works, including but not limited to, design, procurement, fabrication, installation, inspection, construction and modifications will comply with the requirements of the Contract.
- 1.4 The Contractor's Quality Plan shall ensure that all goods and materials, whether on-shore in India or off-shore before shipping, workmanship, plant and equipment procured and supplied, inspecting, handling, assembling, testing, storing, fabrication, suppliers and vendors are in compliance with the Contract requirements. Plan(s) and/or Procedures to be prepared by others (suppliers, subcontractors, sub-consultants) and their incorporation in the overall Quality Plan of the Contractor, shall be identified.
- 1.5 The Capitalized terms used and to the extent not defined herein shall have the meaning ascribed to them respectively, in the Conditions of Contract and the Employer's Requirements.
- 1.6 Construction / Installation shall be deemed to include manufacturing, fabrication, assembling, testing & commissioning, integrated testing and commissioning and trial runs wherever necessary.
- 1.7 The Contractor shall assist in the independent audit review, checking, sampling testing and examination of the Works by the Employer/Engineer. The Contractor shall provide full and timely access for such work by the Employer/Engineer, including inspection of records and documentation. Such access shall include direct access to the Site, work areas, storage facilities, fabrication sites, Contractor's offices, laboratories, manufacturers/suppliers facilities and similar areas and facilities where any work is being conducted.
- 1.8 For design and/or activities occurring outside of India which require the Employer/Engineer to inspect, the Contractor shall provide:
 - (a) Right to inspect;
 - (b) Facilities to carry out their work; and
 - (c) Assistance in travel and accommodation arrangements.

2. QUALITY MANAGEMENT SYSTEMS

- 2.1 Contractor's Quality Management System shall be capable of demonstrating by self-certification that all relevant standards, regulations, testing requirements etc are being met. Self-certification is the process whereby the Contractor can demonstrate that all requirements of the Contract have been fulfilled.
- 2.2 The Contractor shall designate a Quality Assurance Manager (QA Manager) who shall be classified as one of the Key Personnel and shall be responsible for overseeing the implementation of the overall Quality Plan for the Contractor. The Quality Assurance Manager shall not report to the Contractor's Project Manager, but shall be directly responsible to and report to a joint venture board, senior management or similar level of the Contractor's organization that is not directly responsible for design or construction.
 - 2.2.1 Refer to Part II – Section A, Clause A15 Key Staff Requirements.
- 2.3 The Contractor shall be required to provide the Quality Assurance Manager with adequate resources and authority to enable the quality of the work on the Contract to be managed effectively. Those resources shall be required to fulfil the requirements for quality assurance, inspection and testing and self-certification as detailed in these requirements.
- 2.4 The Contractor shall be required to provide appropriate training to all personnel in the operation of the Quality Management System and maintain records to demonstrate competence in its application.
- 2.5 The Contractor shall submit his Quality Management System documentation for review and approval by the Employer/Engineer as specified in this Section.
- 2.6 It is anticipated that the Contractor's Quality Management System documentation shall include, but not limited to, the following:
 - (a) Quality Plan, identifying its Quality Procedures;
 - (b) Manufacturing Quality Plan;
 - (c) Design Quality Plan;
 - (d) Method Statements;
 - (d) Inspection and Test Plans; and
- 2.7 The Contractor shall plan, perform and record all quality control activities to ensure that all work is performed in accordance with the requirements of the Contract and of his Quality Management System. Documentation which have been reviewed and noticed/approved by the Employer/Engineer, such activities shall include, without limitation, the inspections and/or tests implied or expressly required by the Contract.
- 2.8 The Employer/Engineer shall designate, if necessary, Quality 'Hold Points' into the Contractor's Inspection and Test Plans for the Contractor's Quality Department to adhere to, or for the Employer/Engineer to attend, on a case-by-case basis at his discretion.
- 2.9 The Contractor shall coordinate the Inspection and Testing necessary to demonstrate that all specified requirements have been met. All non-conformances are to be documented and resolved, before final acceptance of the Works or any section of it.

- 2.10 The Employer, Stake holders, Engineer and third parties including the Ministry of Railways and statutory authorities, reserve the right to and shall conduct periodic audits and inspections on the Works and services provided either on its own or through third party, and will sample, test and measure material used within the Works completed by the Contractor or its subcontractors of all tiers and suppliers/vendors and to observe the execution of these activities.
- 2.11 The Contractor, his consultant, subcontractors of all tiers and suppliers thereof shall make available for audit all records necessary to demonstrate that the Works have been executed in accordance with the Contract. They shall also provide the Employer/Engineer with documents that demonstrate that the Works are progressing in accordance with the specified requirements. These shall be provided in a timely manner to enable non-conformities to be rectified satisfactorily.

3. QUALITY SYSTEM REQUIREMENTS

- 3.1 The organization of the Contractor's Project Plan shall comply with ISO 10005 (2005): Quality Management-Guidelines for Quality Assurance Plan.
- 3.2 All on-Site and off-Site testing sampling in India is to be carried out by laboratories accredited by NABL (National Accreditation Board of Testing and Calibration Laboratories) or internationally accredited laboratory to ISO 17025: 2005.
- 3.3 A fully equipped concrete laboratory shall be installed at Site along with laboratory technicians and support staff. Testing machines shall be periodically calibrated in accordance with NABL requirements. Details included in clause 14.9.
- 3.4 The Employer/Engineer may require the Contractor to stop using a particular laboratory and find an alternative if the Employer/Engineer has reasonable grounds to be dissatisfied with its performance.
- 3.5 All testing of systems, software, plant and materials must be carried out by persons accredited to meet the requirements and Standards.
- 3.6 Within thirty (30) days of the Commencement Date, Contractor shall submit to the Employer/Engineer for his review, comment and Notice to Proceed the following, as appropriate:
 - (a) Quality Plan;
 - (b) Design Quality Plan and Delivery Schedule; and
 - (c) Manufacturing Quality Plan and Delivery Schedule.
- 3.7 The Contractor shall promptly supply the Employer/Engineer with six (6) controlled copies of his Quality Plans, Inspection and Test Plan(s), related procedures / instructions / forms upon such documents being reviewed and noticed/approved by the Employer/Engineer. The Contractor shall maintain such controlled documentation throughout the duration of the Contract. For any amendment to the quality system documentation, the Contractor shall as soon as practicable prepare and submit the proposed amendment for review by the Employer/Engineer. In addition, the Employer/Engineer may request further copies of the quality system documents and these documents shall reach the Employer/Engineer's office within fourteen (14) days of notification, at no additional cost to the Contract.
- 3.8 The Contractor shall maintain and make available for inspection by the

Employer/Engineer at its site, a complete, up-to-date, organized file of all submittals (plans, procedures, Method Statements etc), including an index and locator system which identifies the status of each submittal.

- 3.9 Pursuant to sub-clause 3.8, a ‘controlled copy’ means a document prepared and issued in accordance with the provisions regarding document control contained in the relevant ISO standard.

4. TYPES OF QUALITY PLANS

- 4.1 No design, procurement, construction, installation, commissioning or maintenance activity shall commence without a suitable Quality Plan that has been submitted to Employer/Engineer for review and comment, consent, approval of Notice to Proceed.
- 4.2 The Contractor shall submit to the Employer/Engineer the following Quality Plans for his review and approval:
- (a) A Quality Plan for the control of all management related activities;
 - (b) Design Quality Plan(s) for the control of all design related activities for the Permanent Works or Plant and/or Temporary Works;
 - (c) Manufacturing and construction Quality Plan(s), for the control of activities within each category of work or discrete element of construction, manufacture, installation, commissioning, maintenance or servicing of the Permanent Works or Plant and/or Temporary Works or for the control of outstanding work during the Contracts Period, as the same may be required by the Contract and/or directed by the Employer/ Engineer; and
 - (d) Method Statements and Inspection and Test Plans, for the control of all inspection and test related activities as per clause 10 and clause 11.

5 FORMAT OF QUALITY PLANS

- 5.1 The Quality Plan(s) shall define all measures necessary to meet the objectives and requirements of the Contract at all appropriate phases of the work.
- 5.2 The Quality Plan(s) shall have a standardised format and show clearly on each page:
- (a) The quality plan number or, in the case of attached documents, a reference to the quality plan number;
 - (b) Whether the document is a draft or is approved by the authorised representative of the Contractor; and
 - (c) The date of such approval.

6 QUALITY PLAN

- 6.1 The Contractor shall prepare construction Quality Plan(s) for the construction, installation, testing and commissioning activities. Separate construction quality plan(s) shall be prepared for other Contractor’s or subcontractor’s off Site activities. Each construction quality plan shall identify the scope of work to be controlled.
- 6.2 The Quality Plan shall include a directory and organizational chart showing all of the Contractor’s Key Personnel. The directory shall be kept updated throughout the Contract as changes occur and submitted to the Employer/Engineer for his

approval/notice. The directory shall include the names, titles, areas of responsibility, office address and location, office phone and fax numbers, cellular phone number(s). The Contractor shall provide information sufficient for the Employer/Engineer to contact any of the Key Personnel on a twenty-four (24-hour) basis for the duration of the Contract.

6.3 The Employer/Engineer will also provide a similar directory to the Contractor.

6.4 The Quality Plan shall define the Contractor's management structure for the execution of the Works and for the control of the quality of the Works and shall, without limitation, define:

- (a) The organisation of the Contractor's managerial staff with particular reference to any Joint Venture partners and main subcontractors. An organisation chart is to be produced to illustrate the subdivision of the work into elements for effective technical and managerial control, the reporting structure and the interface relationship between all parties involved;
- (b) The specific allocations of responsibility and authority given to identified personnel for the day to day management of the work with particular reference to the supervision, inspection and testing of the work;
- (c) The interfacing or co-ordination required with the Contractor's other related Quality Plans;
- (d) The specific methods of construction to identify any relevant Method Statements and develop those Method Statements to a degree of detail sufficient to permit the Employer/Engineer to understand. Refer to clause 10;
- (e) The appointment of a Quality Assurance Manager and Quality Control Manager in accordance with clause 12;
- (f) The audit procedure, audit schedule for each type of quality plans and list of proposed auditors including details of their authority, qualifications and experience in accordance with clause 9;
- (g) The procedures for the control of receipt and issue of all correspondence, so as to ensure traceability, shall be defined. Correspondence shall include letters, internal memoranda, facsimiles and electronic transmittals (i.e. CompuServe, Internet, SharePoint, Expedition etc);
- (h) The procedures for recording Project related oral communications shall be defined, i.e. records of telephone conversations, notes of informal discussions and minutes of meetings;
- (i) The procedures for the selection, indexing, filing, disposition and maintenance of Project records for storage in the archives shall be defined. A list of items to be archived shall be submitted for review by the Employer/Engineer on periods of retention. In addition, the Contractor's and subcontractor's filing systems shall be compatible as far as is necessary;
- (j) The procedures for the identification, production, verification, approval, distribution, implementation and recording of changes to all drawings, reports and specifications shall be defined;

- (k) The procedures for the evaluation, selection, engagement and monitoring of subcontractors / suppliers shall be defined together with the means of application of quality assurance to their work including audit and acceptance;
- (l) The procedure for the regular review and revision of each type of quality plan and its supplemental individual specific quality plans, to ensure their continuing suitability and effectiveness shall be defined. In addition, the method to be used for revision and issue of revised documentation shall be defined;
- (m) The procedures for the control, calibration and maintenance of inspection, testing and measuring equipment shall be defined;
- (n) The procedures for identifying training needs and for the provision of training of all personnel performing activities affecting quality shall be defined; and
- (o) The quality control procedures to be implemented to verify conformance with the Contract specifications. Verification is accomplished by examinations, tests, measurement and inspection and by verifying records including those of his consultant, subcontractors and suppliers by uses of forms to be applied to manage and control the following:
 - (i) The purchasing of materials and ensuring they comply with the requirements of the specification, including purchasing documentation and specific verification arrangements for Contractor/ Employer/Engineer inspection of material or manufactured product prior to release for use/installation;
 - (ii) The construction process including Temporary Works so as to ensure compliance with drawings and specifications;
 - (iii) The construction and installation process so as to ensure clear identification and traceability of material and manufactured parts;
 - (iv) The inspection and testing activities of incoming materials, in process and final product;
 - (v) The identification of the inspection and test status of all material and manufactured products during all stages of the construction and installation process to ensure that only products that have passed the required inspections and tests are dispatched for use and/or installation;
 - (vi) Record of non-conformities and the disposition of non-conforming material or product, supported by applicable documentation, agreed remedial action instituted prior to the initiation so as to avoid unintended use/installation. Contractors Non-conformity system provides for the monitoring and tracking of all Non-conformities that occur within his scope of Contract, regardless of who identifies the Non-conformance;
 - (vii) The assessment and disposition of nonconforming material(s) and product(s) and approval for reworking or rejection as scrap;
 - (viii) The identification of preventive action so as to prevent recurrence of similar non-conformance; and
 - (ix) The handling, storage, packaging, preservation and delivery of products.
- (p) The list of Inspection and Test Plans and Method Statements to manage and control any test and inspection activities;
- (q) All particulars of materials submitted for review by the Employer/Engineer;

- (r) Where required by the Contract, the quality control requirements for major components in accordance with clause 16; and
- (s) Lists of forms and formats to be used to record the activities under the construction Quality Plan(s) shall be attached at the end of each section or reference included to existing standard procedures.

- 6.5 The Quality Plan(s) shall ensure that conditions adverse to quality such as failures, malfunctions, deficiencies and defects in materials and equipment shall be promptly identified and recorded as Non-Conforming Product and specific procedures to rectify non-conformities raised. This includes systems non-conformities raised as a result of both internal audit by the Contractor and external audits by the Employer/Engineer.
- 6.6 The Quality Plan(s) shall address the controls to be applied by its organisation to its subcontractors, suppliers and lower tier contractors thereof, both directly and by identifying the quality system documentation that subcontractors, suppliers and lower tiers thereof are required to produce. The Contractor shall ensure that subcontractors, suppliers and lower tiers thereof agree to and implement the applicable controls specified in the Contractor Quality Plan and the identified Quality Management System documentation.

7 DESIGN QUALITY PLAN

- 7.1 The Contractor shall be responsible for the management of the design of the Works. While not being responsible to do any design for any Interfacing Party, the Contractor shall use his best endeavours to manage and resolve the interface, including those with designers of track-work and system elements such as E&M, signalling and telecommunications, PSD and power system & LV.
- 7.2 The Contractor shall be responsible for coordinating with and obtaining necessary approvals from cognizant authorities for temporary and permanent road diversions, including overpasses and underpasses. The Contractor shall copy the Employer/Engineer on all correspondence with the cognizant authorities and shall note any problems in the Progress Narrative, submitted with the Monthly Progress Report.
- 7.3 The Contractor shall ensure that the designs of the Works are properly checked and dealt with by a Design Checker whom shall be identified within the organisation of the Contractor. The Lead Design Checker shall be independent in-house responsible for the detailed Checking of Deliverables prior to submission and ensure that the design can meet all its obligations under the Contract and for the Contractor to do likewise. The Lead Design Checker shall issue a certificate of the same to the Employer/Engineer.
- 7.3.1 Refer to Part II - Section C, Attachment C1.
- 7.4 The Contractor shall identify the Design Checker for each discipline. The Lead Design Checker shall have not less than the competence and experience required of the Contractor's Designer in the same discipline as the discipline of the design to be checked.
- The Lead Design Checker shall not be associated with or be involved in the actual design, producing design documents or conducting construction site supervision for the Contractor.
- 7.4.1 Refer to Part II - Section C, Attachment C1.

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- 7.5 In the event that the Employer/Engineer identifies significant errors or inconsistencies in the Deliverables, then the Employer/Engineer shall request for the applicable Design Checker to be immediately removed from the Design Team and be replaced with a competent Checker.
- 7.6 The procedures for the checking of design of Permanent Works shall also apply to design of Temporary Works and construction sequences that affect the Permanent Works or Safety during construction / installation.
- 7.7 The procedures for the control of design changes shall be defined in order that design changes are reviewed, verified, validated and approved before implementation.
- 7.8 All design documents (drawings, plans, specifications, calculations and reports) produced by the Contractor's organization shall be checked by the Designer, whom shall issue a certificate of the same to the Employer/Engineer.
- 7.8.1 Refer to Part II - Section C, Attachment C1.
- 7.9 The Contractor shall maintain records showing design calculation and data supporting design review activities.
- 7.10 The Employer/Engineer reserves the right to inspect and audit these documents at any time to verify the effectiveness of design reviews.
- 7.11 The Design Quality Plan(s) shall define the Contractor's policy for the design of the Permanent Works or Plant and/or Temporary Works and shall, without limitation, define:
- (a) The organisation of the Contractor's design staff;
 - (b) The specific allocations of responsibility and authority given to identified design staff with particular reference to the review and verification of design drawings and calculations by the Contractor;
 - (c) The specific methods of design to identify any relevant Method Statements and develop those Method Statements to a degree of detail sufficient to permit the Employer/Engineer to understand;
 - (d) The procedures to be applied to manage and control the quality of the design work, with particular reference to the following:
 - (i) The design and performance requirements which shall be defined in terms of basic data and design assumptions made; relevant codes, standards and regulatory requirements; safety, security and environmental requirements; and commissioning requirements;
 - (ii) The design methods. Software applications to be used in the design, both proprietary and public domain, shall be identified and any requirements for physical and mathematical model testing;
 - (iii) The preparation, checking, issue, distribution, indexing and filing reports, calculations, drawings and specifications along with the means of their revisions;
 - (iv) The formal design review, authorisation and approval of design documentation;
 - (v) The design verification and validation;
 - (vi) The design checks by the Design Checker; and
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- (vii) List of examples of the forms and formats to be used to record the activities under the Design Quality Plan shall be attached at the end of each section or a reference included to existing standard procedures.
- (e) For the following, the Employer/Engineers review and Notice to Proceed is required before proceeding with the next stage of the works or design;
 - (i) The design of temporary traffic arrangements shall be reviewed and noticed by the Employer/Engineer before submitting the same to the relevant authorities;
 - (ii) The design of excavation and lateral support systems for underground excavations shall be reviewed and noticed by the Employer/Engineer before the excavation commences;
 - (iii) The design of formwork and false work for cast insitu and precast concrete works shall be reviewed and noticed by the Employer/Engineer before the erection of the same commences;
 - (iv) The implementation of temporary traffic arrangements shall be reviewed and noticed by the Employer/Engineer before the associated works proceed.
 - (V) Utility structure support scheme (if any) shall be reviewed and noticed by the Employer/Employers Representative before the associated work proceed.

8 MANUFACTURING QUALITY PLAN

- 8.1 Each Manufacturing Quality Plan shall identify the scope of work to be controlled. In relation to such scope of work, it shall, without limitation, define:
- (a) The organisation of the Contractor's staff directly responsible for the day to day management of the work on or off the Site;
 - (b) The specific allocations of responsibility and authority given to identified personnel for the day-to-day management of the work with particular reference to the supervision, inspection and testing of the work;
 - (c) The interfacing or co-ordination required with the Contractor's other related Quality Plan(s);
 - (d) The specific methods of manufacture to identify any relevant Method Statements and develop those Method Statements to a degree of detail sufficient to permit the Employer/Engineer to understand;
 - (e) The procedures, instructions and forms to be applied to manage and control the following:
 - (i) The purchasing of materials and ensuring they comply with the requirements of the specification, including purchasing documentation and specific verification arrangements for Contractor/ Employer/Engineer inspection of material or manufactured product prior to release for use/installation;
 - (ii) The manufacturing process so as to ensure compliance with drawings and specifications;
 - (iii) The manufacturing process so as to ensure clear identification and traceability of material and manufactured parts;

- (iv) The inspection and testing activities of incoming materials, in process and final product;
 - (v) The identification of the inspection and test status of all material and manufactured products during all stages of the manufacturing process to ensure that only products that have passed the required inspections and tests are dispatched for use and/or installation;
 - (vi) The review and disposition of non-conforming material or product so as to avoid unintended use/installation;
 - (vii) The assessment and disposition of nonconforming material and manufactured product and approval for reworking or rejection as scrap;
 - (viii) The identification of preventive action so as to prevent recurrence of similar non-conformance; and
 - (ix) The handling, storage, packaging, preservation and delivery of manufactured product.
- (f) The Inspection and Test Plans to manage and control any test and inspection activities;
- (g) All particulars of materials submitted for review by the Employer/Engineer;
- (h) Where required by the Contract, the quality control requirements for major components in accordance with clause 14; and
- (i) List of forms and formats to be used to record the activities under the Manufacturing Quality Plans shall be attached at the end of each section or reference included to existing standard procedures.

9 QUALITY AUDIT, REVIEWS AND UPDATES

- 9.1 Contractor shall submit with his Quality Plan a schedule of internal, consultant, subcontractor and supplier audits that are to be conducted by his personnel at least every six (6) months. The schedule, scope and method of the audits shall be sufficient enough, such that the Contractor can verify that all aspects of the Works are being conducted in accordance with the contractual requirements. The schedule and any amendments are subject to the acceptance by the Employer/Engineer. The schedule shall be reviewed every four(4) weeks by the Employer/Engineer.
- 9.2 The Contractor shall ensure that audits of all the activities in each quality plan are carried out to ensure the continuing suitability and effectiveness of the Quality Management System. Reports of each such audit shall be submitted promptly to the Employer/Engineer for his information.
- 9.3 The Contractor shall audit his consultants, subcontractors, sub-consultants and suppliers.
- 9.4 The Contractor shall allow the Employer/Engineer to observe/participate in these audits and to conduct additional independent audits, as they consider appropriate to provide assurance that the Works are being conducted in accordance with contractual requirements. The Contractor shall provide the facilities and access necessary for these audits to be carried out effectively.
- 9.5 All audits as described in this section are to be carried out in compliance with established ISO 9001 auditing principles and in accordance with ISO 19011.

9.6 Plan reviews and updates:

- (a) The Contractor shall conduct Management Reviews of its quality system, at least annually. As work progresses, the Contractor shall update the Quality Plan to reflect current conditions. The need for revisions to the Quality Plan may be identified by the Contractor and/or the Employer/Engineer. The Contractor shall submit any revisions or updates to the Quality Plan to the Employer/Engineer for his Notice to proceed within thirty (30) days of the identification of the need for a revision.
- (b) In addition, the Contractor shall submit its Quality Plan for review by the Employer/Engineer annually even if no revisions have occurred during the preceding twelve (12) months. The Contractor shall submit a certified copy of the updated Quality Plan with revisions highlighted.

10 METHOD STATEMENTS

- 10.1 Contractor shall prepare Method Statements for each area and/or type of activity conducted, and submitted to the Employer/Engineer for his review, comment and Notice to Proceed prior to commencing construction on any Temporary or Permanent Works. Methods Statements shall be prepared for all Temporary and Permanent Works and shall be specific to the work being constructed and to the location of work.
- 10.2 All Methods Statements shall be consistent with Design Drawings and Works Specifications that have been subjected to checks and reviews as specified.
- 10.3 Any deviations from the requirements of the Design Drawings or Works Specifications shall require written agreement of the Designer, certified by the Design Checker and shall be submitted to the Employer/Engineer for his review and Notice to Proceed.
- 10.4 Approved Methods Statements shall be available for examination by the Employer/Engineer upon request at site.
- 10.5 Method Statements shall address the following items:
 - (a) Scope of work covered by the Method Statement;
 - (b) Relevant drawings and Works Specifications;
 - (c) Hazard analysis and the precautions to be taken to eliminate or mitigate identified hazards;
 - (e) Methods to be used and programme for the work;
 - (f) Resources (plant and labour);
 - (g) Supervision to be provided (by name);
 - (h) Safety provisions;
 - (i) Environmental provisions;
 - (j) Traffic control and temporary diversions to be implemented; and
 - (j) Inspection and Test Plan.
- 10.6 The Contractor shall reference applicable portions of previously prepared plans, such as the Safety Plan or Quality Plan, in its Method Statements.

11 INSPECTION AND TEST PLANS

- 11.1 The Contractor, and through him, his consultants, subcontractors and suppliers engaged in supplying, manufacturing, construction, installation, commissioning and testing or any other service connected with the Works, shall maintain Inspection and Test Plans (ITP) appropriate for the services they provide that are accepted by the Employer/Engineer. These accepted ITP's will stipulate the necessary level and frequency of tests and inspections for each aspect of the Works, and also stipulate, without limitation:
- (a) The personnel responsible and/or involvement of various parties for undertaking and certifying the inspection and/or testing;
 - (b) The procedure or instructions for the inspection and/or testing;
 - (c) The test method or a reference to the relevant standard of testing;
 - (d) The inspection and/or testing required prior to commencement of an activity;
 - (e) The inspection and/or testing during an activity and its frequency;
 - (f) The inspection and/or testing required for the completion of an activity;
 - (g) All Quality 'Hold Points' (H), 'Witness Points' (W) and 'Observation Points' (O) shall be identified by the Contractor for his Quality Department to inspect and verify its acceptance;
 - (h) The Employer/Engineer can place additional Quality 'Hold Points' (H), 'Witness Points' (W) and 'Observation Points' (O) for the Contractor's Quality Department on a case-by-case basis; and
 - (i) Employer/Engineer may designate additional Quality 'Hold Points' for his inspection on a case-by-case basis.
- 11.2 The Contractor shall conduct inspections and tests in accordance with his detailed plans as stipulated in the ITP. Records shall be kept of the completion of the inspections and tests that identify the record of the results which shall be made available for review during Employer/Engineer audit.

12 QUALITY PERSONNEL

- 12.1 The Contractor shall appoint a suitably qualified and experienced person(s) as the 'Quality Assurance Manager' to be responsible for the task of ensuring that the requirements of the Quality Management System are implemented and maintained. The Contractor shall, at the time of submission of the proposed management Key Personnel, shall submit for review by the Employer/Engineer details of the qualifications, experience, authority and responsibility of the proposed Quality Assurance Manager.
- 12.2 The Contractor shall ensure that the Quality Assurance Manager is able to discharge his duties without hindrance or constraint. In addition, the Contractor shall make available any such resources that are necessary to ensure the effective implementation of the quality system and all quality plans.
- 12.3 The Contractor shall appoint a suitably qualified and experienced person as the 'Quality Control Manager' to lead teams of Quality Control Engineers for carrying out, independent from other teams, inspections of the Works as identified as the Quality 'Hold Point', 'Witness Point (W)', 'Observation Point (O)'. The Contractor shall, at the

time of submission of the proposed management Key Personnel, submit for review by the Employer/Engineer details of the qualifications, experience, authority and responsibility of the proposed Quality Control Manager.

12.3.1 Refer to Clause 15 Section A, of this Part II for the qualification requirements for Key Staff.

12.4 The Contractor shall ensure that the Quality Control Manager is able to discharge his duties without hindrance or constraint, including but not limited to the authority to suspend works as considered necessary. In addition, the Contractor shall make available any such resources that are necessary to ensure the effective implementation of the quality system and all quality plans.

12.5 Quality Control Engineers:

The Contractor shall assign Quality Control Engineers for each shift for each location/activities where work is being performed. Each lead inspector shall be qualified by training and experience in all the construction activities being conducted at the Site.

Quality Control Engineers shall have a minimum of ten (10) years construction / installation experience with at least five (5) years' experience in the inspection, sampling and testing of works of the type being constructed. If required on the request of Employer/Engineer additional inspectors shall be appointed, at no additional cost to the Contract.

12.6 Materials Technicians:

The Contractor shall assign qualified materials technicians to conduct the sampling and testing of materials, goods and supplies for the Contract.

12.7 Staffing Levels:

The actual size of the Site staff shall reflect the complexity, needs, shifts and composition of Quality Control activities consistent with work in progress. The staffing levels shall be consistent with the Contractor's Quality Plan and the Project Baseline Programme, the relative locations of work in progress and the nature of the work.

The Quality Plan shall identify administrative/clerical support for the maintenance and management of records/documents pertinent to Quality Control activities.

13 MONTHLY PROGRESS REPORT

13.1 The Contractor shall continuously monitor the performance of his Quality Management System, which shall be included in each Monthly Progress Report (MPR) in accordance with Part II – Appendix 5.

13.2 Quality Certifications:

The Contractor shall submit a written certification by the Quality Assurance Manager certifying that:

(a) The Quality Plan and all of the measures and procedures provided therein are functioning properly and are being fully complied with, except as specifically noted in the certification.

(b) All work, including that of the Designer, and all other designers, subcontractors at all tiers, suppliers and fabricators, has been checked and/or inspected by the

Contractor's Designer Checker, except as specifically noted in the certification, conforms to the requirements of the Contract.

Refer to Part II - Section C, Attachment C1.

13.3 Weekly

Weekly records shall be prepared and maintained that provide factual evidence that required activities and/or tests have been performed, including the following:

- (a) Type, number and results of quality assurance and quality control activities, including but not limited to reviews, inspections, tests, audits, monitoring of work performance and materials analysis;
- (b) Qualifications of personnel, procedures and equipment used;
- (c) The identity of the Quality Control Engineer or data recorder, the type of test or observation employed, the results and the acceptability of the work and action taken in connection with any deficiencies noted;
- (d) Nature of nonconforming work causes for rejection, with photographs etc;
- (e) Preventive actions;
- (f) Proposed corrective actions;
- (g) Corrective actions taken and with whose authority; and
- (h) Results of corrective actions.

13.4 The Employer/Engineer reserves the right to inspect and audit these documents at any time.

14 QUALITY CONTROL REQUIREMENTS

14.1 The Contractor shall, in accordance with the quality control requirements of the Specification and other documents included in the Contract, prepare and maintain quality item lists which establish the criteria for control of each major component or activity during design, construction and/or manufacture and installation, commissioning and servicing in accordance with the need to ensure the desired quality requirements of the Works.

14.2 All inspection and testing shall be the responsibility of the Contractor, at Contractor's cost. In all cases, the cost of materials for such tests shall be borne by the Contractor.

14.3 The work shall conform to high standards of material, design and workmanship. The Contractor shall conform to the Quality standards prescribed in the Contract document(s).

14.4 At Site, the Contractor shall arrange the materials, their stacking/storage in appropriate manner to ensure that the quality of the materials is not compromised. The Contractor shall provide all the necessary equipment and qualified manpower to test the quality of materials, assemblies etc. The tests shall be conducted at specified intervals and the results of tests properly documented.

14.5 The Employer/Engineer shall be free to carry out such additional tests as may be decided by him at his sole discretion, from time to time, in addition to those specified in this document. The Employer/Engineer shall also be free to appoint any third party for inspection and testing of important items like stay cables and steel work including welding etc, at his own cost. The Contractor shall provide the samples and labour for

collecting the samples. No extra payment shall be payable to the Contractor for samples or for the collection of the samples. The results of such additional tests and third party inspection shall be binding on the Contractor.

- 14.6 The test(s) shall be conducted at the Contractor's Site laboratory which shall be established by the Contractor or at any other standard external laboratory selected by the Employer/Engineer. The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of the Contractor failing to arrange transportation of the samples in proper time, the Employer/Engineer shall have them transported and recover two times the actual cost from the Contractor. All sampling and testing shall be performed in the presence of assigned Contractor Quality Personnel. Testing may be witnessed by the Contractor or his authorised representative if permitted by the Standard External Laboratory. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.
- 14.7 The Employer/Engineer shall have the right at all times to inspect all operations including the source of materials, procurement, layout and storage of materials, all equipment including the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and the Employer/Engineer's approval obtained prior to starting of the particular item of work. This shall however, not relieve the Contractor of his responsibilities.
- 14.8 All materials which do not conform to the Specifications shall be rejected and shall be removed from the Site immediately. The Employer/Engineer shall have the power to cause the Contractors to purchase and use materials from any particular source, as may, in the Employer/Engineer's opinion, be necessary for the proper execution of Works.
- 14.9 Field/Site Laboratory
- 14.9.1 All the materials to be used in the work and tested in the laboratory shall comply with the Employer's Requirements or such recognised specifications as acceptable to Employer/Engineer as detailed in clause 3.2 and 3.3 respectively.
- 14.9.2 The testing machines shall be recalibrated periodically as per Contractor Quality Plan and applicable regulatory Standards. The calibration shall be from an authorized laboratory in accordance with clause 3.2 and approved Employer/Engineer.
- 14.9.3 The Contractor or his authorised representative shall assist in the collection, preparation, forwarding and testing of such samples. The cost of such samples and tests shall be borne by the Contractor. The Contractor shall give not less than seven (7) days' notice for all tests in order that the Employer/Engineer may attend and witness testing at the external laboratory. Two (2) copies of all test certificates shall be supplied by the Contractor to the Employer/Engineer for approval immediately after the completion of the tests. Test certificates must be supplied to the Employer/Engineer before the materials or components are used in the works, unless the Employer/Engineer directs otherwise.
- 14.10 Frequency of Testing
- All materials shall be tested as per the requirements specified in the Contractor's Quality Plan and Annexure I. All test reports shall be documented in hard copy as well as soft copy.
- 14.11 Unsuitable Materials

If at any stage of execution of work, Employer/Engineer finds that the particular material is not suitable to be used in any component of the work, the Employer/Engineer may order retesting of the material from any approved laboratory at the cost of the Contractor. The rejected material either after the initial test or after re-testing, as the case may be, shall be immediately removed from the Site by the Contractor at his own cost. In case of default on the part of the Contractor in removing rejected materials and any work executed with such unaccepted materials, the Employer/Engineer shall be at liberty to have them removed and/or dismantled by other means at the risk and cost of the Contractor.

15 NOTIFICATION OF NONCONFORMITIES

- 15.1 If the Contractor has used or proposes to use or repair any item of the Works which does not conform to the requirements of the Contract, he shall immediately submit for review by the Employer/Engineer a proposal for rectification, and supply full particulars of the nonconformity and, if appropriate, of the proposed means of repair.
- 15.2 If the Employer/Engineer issues nonconformity reports, either product based as a Non-Conformance Report (NCR) or procedural through quality audit as a Corrective Action Request (CAR) or similar documents to notify the Contractor of any item of the Works which does not conform to the requirements of the Contract, the Contractor shall promptly investigate the matter and submit for review within fourteen (14) days of notification by the Employer/Engineer of the remedial measures to be taken and stating the reasons for the measures and the corrective and preventive action.
- 15.3 The Contractor shall maintain a Non Conformity Register to indicate the status of all nonconformities which have been identified by the Employer/Engineer and the Contractor.
- 15.4 The Employer/Engineer reserves the right to inspect and audit these documents at any time.

16 NOTICE OF PLACE OF MANUFACTURE AND/OR SOURCE OF SUPPLY

The Contractor shall notify the Employer/Engineer of the places of manufacture and/or the source of supply of all goods and materials to be incorporated into the Works and shall give reasonable notice (which shall not in any event be less than fifty-six (56) days) to the Employer/Engineer before the start of any manufacturing and/or the supply of goods and materials.

17 NOTICE OF INSPECTION, TEST, TRIALS BY THE CONTRACTOR

In relation to all Quality Control points and Quality 'Hold Points' involving inspection and/or witness testing by the Employer/Engineer, the Contractor shall give the Employer/Engineer notice of when the relevant work will be inspected and/or tested. The period of notice shall be as follows; unless otherwise agreed by the Employer/Engineer:

- (a) In the case of on-Site work, such notice shall be given not less than forty-eight (48) hours of normal working time before the work is to be inspected and/or tested;

- (b) In the case of work carried out off-Site in Pune, such notice shall be given not less than fourteen (14) days before the work is to be inspected and/or tested; and
- (c) In the case of work carried out offshore outside of India, such notice shall be given not less than twenty-eight (28) days before the work is to be inspected and/or tested

18 WITNESS BY THE EMPLOYER/ENGINEER

In relation to all Quality Control Points involving inspection and/or testing by the Contractor, the Employer/Engineer may elect to witness such inspections and/or tests but, on expiration of the period of notice pursuant to clause 17, the Contractor may proceed with the inspections and/or tests notwithstanding the absence of the Employer/Engineer or of any response to the said notice. Witness by the Employer/Engineer shall not discharge the Contractor of the responsibility to provide acceptable product, nor shall it preclude subsequent rejection by the Employer/Engineer.

19 CERTIFICATE OF MANUFACTURED GOODS OR MATERIALS

- 19.1 The Contractor shall obtain certificates for each batch of manufactured goods and documentary evidence that goods, supplies and materials and Contractor's Equipment conform to the Contract requirements for incorporation in the Works. Each certificate and/or proofing document shall include all reports of inspections and/or tests carried out at the place of manufacture.
- 19.2 The Contractor shall make available at the Site no less than twenty-four (24) hours prior to installation or use of such goods, supplies or materials and Contractor's Equipment all certificates and/or proofing document(s).
- 19.3 The Employer/Engineer reserves the right to inspect and audit these documents at any time.
- 19.4 Materials Certificate of Compliance:
Within seven (7) days of the issue of a Completion Certificate for a Section or for all the Works, the Contractor shall submit a Certificate of Compliance signed by the Project Manager and the Quality Assurance Manager indicating that all materials, goods and supplies incorporated in the Works conform to the requirements of the Contract.

20 REPORTS OF INSPECTIONS, TESTS AND TRIALS

- 20.1 The Contractor shall compile reports of each inspection and/or test. Such reports shall show the results of all the inspections and/or tests carried out and shall certify that the work has been inspected and/or tested in accordance with the requirements of the Contract and that the work complies with the requirements of the Contract. Any analysis of the results required to confirm that the work complies with the requirements of the Contract shall be compiled in accordance with clause 21 and reported to the Employer/Engineer in accordance with clause 23.

- 20.2 Each report of inspection and/or test shall be signed by a representative of the Contractor who has been allocated the requisite authority under the relevant Inspection and Test Plan and signed by the Contractor's Quality Assurance Manager.
- 20.3 The Employer/Engineer reserves the right to inspect and audit these documents at any time.

21 TIME LIMIT FOR FILING OF REPORTS FOR INSPECTIONS AND/OR TESTS

The Contractor shall ensure that a signed copy report of each in-situ and each off-site inspection / test is filed in his Records Office within 3 (three) working days and within seven (7) working days of the date of completion of the test process respectively.

22 QUALITY CONTROL REGISTER

- 22.1 The Contractor shall provide and maintain at all stages of the work a quality control register or registers to identify the status of inspections, sampling and testing of the work and all certificates. Each register shall:
- (a) List the certificates received for each batch of manufactured goods or materials incorporated in the Works and compares this against the certification required by the Contract and the Contractor's Quality Plan(s);
 - (b) List the inspection, sampling and testing activities undertaken by the Contractor on each element of the Works and compare these activities against the amount of inspection, sampling and testing required by the Contract and the Contractor's Quality Plan(s);
 - (c) Show the results of each report of inspection and/or test and any required analysis of these results and compare these results against the acceptance criteria, including:
 - (i) Standard deviation and coefficient of variation for each grade of concrete;
 - (ii) Summary of trial mix for each grade of concrete;
 - (iii) Summary of sample type and quantity that has been sent for third party testing;
 - (iv) Summary of third party testing reports;
 - (v) Summary of calibration status of monitoring and measurement equipment, batching plant/s; and
 - (vi) Summary of in-process testing for routine dynamic pile load test, static pile load test, lateral load test (if required) and pile integrity test etc that have been conducted that month.
 - (d) Cumulative quantity of each grade of concrete produced from RMC and/or dedicated batching plant/s;
 - (e) Summary of Non Conformance Reports (NCR), raised internally by Contractor in its Quality Management System and as directed by Employer/Engineer.
- 22.2 The Employer/Engineer reserves the right to inspect and audit these documents at any time.

23 SUMMARIES OF INSPECTION AND/OR TEST

- 23.1 The Contractor shall submit to the Employer/Engineer for his information summaries based on each quality control register showing the type and amount of certification received and the sampling, inspection, and/or testing undertaken on each element of the Works during the previous week as part of the Weekly Report, in accordance with clause 13.3. The summaries shall identify and demonstrate the compliance of such certification, sampling, inspection and/or testing with the requirements of the Contract and shall identify any item which does not conform to the requirements of the Contract.

24 SAMPLES

- 24.1 The Contractor shall ensure those concrete compression test specimens are controlled as followed:
- (a) each sample is identified in accordance with clause 24.3;
 - (b) all samples are protected, temporarily stored, handled and transported to the laboratory under the direct supervision of a suitably qualified representative of the Contractor's laboratory;
 - (c) no samples are mislaid, damaged, or contaminated, and
 - (d) the properties of the sampled material are at no time adversely affected.
- 24.2 All samples for testing shall be fully prepared for transportation and testing by the Contractor and shall be delivered by the Contractor to the place of testing.
- 24.3 The Contractor shall ensure that concrete test specimens are identified by a unique reference which, at a minimum, shall contain at least four fields of reference. The sample reference shall be in the form of 'LLNN / LNN / NNNN / LLNN' where:
- (a) 'LLNN' is the alpha-numeric Contract number;
 - (b) 'LNN' is the alpha-numeric concrete design mix, for example M25 ('M' refers mix and the number '25' represents the characteristic compressive strength of 15cm cube at 28-days in MPa);
 - (c) 'NNNN' represents the date of sample with 'day-month'; and
 - (d) 'LLNN' is the alpha-numeric Transit Mixer, for example 'TM01'
- 24.4 For all test samples, the Contractor shall ensure that all samples are identified by a unique number in accordance with its quality control procedure for inspection and test status of materials and manufactures products and shall contain the required identification for traceability. At a minimum, the identification reference shall consist of:
- (a) Contract number;
 - (b) Test identification code assigned by the Contractor;
 - (c) Date of sample with 'day-month'; and
 - (d) Unique sequential number of the sample under the particular test identification Code.
- 24.5 Additional fields may be added by the Contractor with the consent of the Employer/Engineer for the control of the laboratory activities and analysis of test results.

25 ADDITIONAL SAMPLES

The Contractor shall provide additional samples for testing if in the opinion of the Employer/Engineer:

- (a) The material previously tested no longer complies with the specified requirements; or
- (b) The material has been handled or stored in such a manner that it is no longer represented by the previously tested samples.

26 TRIALS

- 26.1 Trials shall be carried out as stated in the Contract to demonstrate that the proposed materials, equipment or methods of construction comply with the Contract.
- 26.2 Trials shall be carried out before commencement of construction or manufacture of the relevant work in order to ensure that proposed methods and materials comply with the specified requirements.
- 26.3 Trials shall be carried out using types of materials and methods of manufacture, construction and/or installation which have been reviewed and approved by the Employer/Engineer.
- 26.4 Unless permitted by the Employer/Engineer, the materials and methods of manufacture, construction and/or installation used in the trial to produce work complying with the requirements of the Contract shall not be changed unless further trials have been carried out to demonstrate that the proposed changes are satisfactory.
- 26.5 All references to 'tests' and 'testing' in the Contract shall, where the context so permits, include trials and commissioning.

27 TIMING FOR INSPECTION BY THE EMPLOYER/ENGINEER

- 27.1 The Contractor shall allow the Employer/Engineer a reasonable time to carry out any inspection and/or witness testing and to assess the result of any inspection and/or test before proceeding with the Works.
- 27.2 Unless the Employer/Engineer's prior consent has been obtained, all inspections and/or tests to be witnessed by the Employer/Engineer shall be carried out between 0800 and 1800 hours, Monday to Saturday.

28 FAILURE OF CONTRACTOR TO INSPECT THE WORKS

The Employer/Engineer may reject the work in question, or require it to be uncovered, in the event of any failure by the Contractor to inspect and/or test at a Quality 'Hold Point' by Contractor's Quality Department.

29 FAILURE OF THE CONTRACT TO TEST THE WORKS

If the Contractor fails to test, either type test or routine test or qualification test, for each batch of goods or elements of the Works, then the Employer/Engineer shall arrange for third party inspection. The Employer/Engineer shall recover two times the actual cost associated with testing, including the services of any specialised personnel or independent assessors, and will deduct such cost from the Contract.

ANNEXURE I

REQUEST FOR INSPECTION (RFI) FOR	
(Details area to be inspected)	
Client :	Contractor :
RFI No.	Date :
Contract Item No : Specification Clause No : ITP/Hold Point Details :	(Specific area and details are requested to be inspected)
Chainage/location : Brief description of Works :	(Specific area and details are requested to be inspected)
Requested by :	
Name :	Position :
Date & Time :	Signature :
Enclosure : (attached QA/QC forms/checklist etc. appropriate to inspection)	
Comments/Recommendations of Employer/Engineer	
Employer/Engineer : OBJECTION /NOTICE TO PROCEED	
(Provide details if OBJECTION)	
Received copy by Contractor's Representative	
Name :	Position :
Date & Time :	Signature :

Note : R.F.I. to be submitted at least 24 Hrs prior to inspection.

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Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 7 – Drafting and CAD Standard

June 2018

1. INTRODUCTION

- (1) The purpose of this document is to define the minimum Drafting and CAD standard to be achieved by the Contractor for all drawings produced by the Contractor for the purpose of the Works. The Contractor shall produce and obtain the Engineer's Notice of No Objection to a CAD Manual which defines the standards and procedures for producing drawings. This will be co-ordinated with the CAD Manuals produced by the Interfacing Contractors.
- (2) By defining a common format for the presentations of drawings and CAD files, the exchange of drawn information is improved and will maximise the use of CAD in the co-ordination process.
- (3) All submissions shall be made to the Engineer in a format reviewed without objection by the Engineer and in accordance with the Contract requirements.
- (4) Paper and drawing sizes shall be "A" series sheets as specified in BS 3429.
- (5) The latest available versions of the following software, compatible for use with Intel- Windows based computers shall be used, unless otherwise stated, for the various electronic submissions required:

<u>Document Type</u>	<u>Electronic Document Format</u>
Text Documents	MS Word, Ver. 2016
Spread Sheets	MS Excel, Ver. 2016
Data Base Files	MS Access, Ver. 2016
Presentation Files	MS PowerPoint, Ver. 2013
Programmes	Primavera P7
AutoCAD Graphics	CorelDraw, Ver. X6/ AutoCAD Ver.21.0
Photographic	Adobe Photoshop 13.0.1.1 (CS6)
Desktop Publishing	Page Maker 7.0.2
CADD Drawings	AutoCAD Ver. 21.0

- (6) Media for Electronic File Submission

Two copies shall be submitted on separate DVDs, unless otherwise stated.

- (7) Internet File Formats/Standards

- (a) The following guidelines shall be followed when the Contractor uses the Internet browser as the communication media to share information with the Employer / Engineer.
- (b) All the data formats or standards must be supported by Microsoft Internet Explorer version 2016 or above running on Windows XP, Vista or Windows 8.1 or Window 10
- (c) The following lists the file types and the corresponding data formats to be used on Internet. The Contractor shall comply with them unless prior Notice is obtained from the Engineer for a different Data format:

File Type	Data Format
Photo Image	Joint Photographic Experts Group (JPEG)
Image other than Photo	GIF or JPEG
Computer Aid Design files (CAD)	Computer Graphics Metafile (CGM)
Video	Window video (.avi)

Sound	Wave file (.wav)
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- (8) The following states the standards to be used on the Internet when connecting to database(s). The Contractor shall comply with them unless prior Notice is obtained from the Engineer for a different standard:

Function to be Implemented	Standard to be Complied With
Database connectivity	Open Database Connectivity(ODBC)
Publishing hypertext language on the World Wide Web	Hypertext Markup Language (HTML)

The hard copy of all documents shall be the contractual copy.

1. GENERAL REQUIREMENTS

2.1 General

- (1) The Engineer shall provide a title block similar to that used in the Employer's Drawings.
- (2) Each drawing shall be uniquely referenced by a drawing number, that shall define both the current status and revision of the drawing. The current status of each drawing shall be clearly defined by the use of a single letter code as follows:
 - P - Preliminary Design Drawing
 - D - Definitive Design Drawing
 - C - Construction Reference Drawing
 - W - Working Drawing
 - B - As-Built Drawing
 - M - As Manufactured Drawing
 - E - Employer's Drawing

2.2 Types of drawings

- (1) **"As-Built Drawings"**: means those drawings produced by the Contractor and endorsed by him as true records of construction of the Permanent Works and which have been given a notice from the Engineer..
- (2) **"Construction Reference Drawings"**: means those drawings referred to in Clause 2(8) of the Employer's Requirements - Design in respect of which a Notice has been issued.
- (3) **"Design drawings"** means all drawings except shop drawings and as-built drawings.
- (4) **"Site drawings and sketches"** means the drawings, often in sketch form, prepared on site to describe modifications of the Working drawings where site conditions warrant changes that do not invalidate the design.
- (5) **"Shop drawings"** means special drawings prepared by the manufacturer or fabricator of various items within the Works to facilitate manufacture or fabrication.

"Working Drawings" means the Construction Reference Drawings and such other drawings and documents, such as bar bending schedules and manufacturing drawings, as are necessary to amplify the Construction Reference Drawings for construction purposes, some of which may be endorsed by the Engineer.

2. COMPUTER AIDED DESIGN & DRAFTING (CAD) STANDARDS

3.1 Introduction

Scope of Use; Data input procedures between the Engineer and Contractors must be co-ordinated, and the key parameters used to form CAD data files must be standardised. The Contractor shall be responsible for coordinating with the Engineer and Interfacing Contractors to prepare, and obtain the Engineers Notice of No Objection to a CAD Manual setting out the production standards and procedures for CAD data files. The production of all CAD data files shall comply with the following requirements.

3.2 Objectives

The main objectives of the CAD standards are as follows:

- (a) To ensure that the CAD data files produced for the Project are co-ordinated and referenced in a consistent manner.
- (b) To provide the information and procedures necessary for a CAD user from one discipline or external organisation to access (and use as background reference), information from a CAD data file prepared by another discipline or external organisation.
- (c) To standardise the information contained within CAD data files which may be common to more than one discipline such as drawing borders, title boxes, grid lines etc.
- (d) To establish procedures necessary for the management of CAD data files.
- (e) To ensure all Contractors use 'Model space' and 'Paper space' in the production of their CAD files'.

3.3 General

- (1) To facilitate co-ordination between Contractors, it is a requirement that all drawings issued by Contractors for co-ordination or record purposes shall be produced using CAD methods. Drawings shall be issued in digital format in addition to the paper copies.
- (2) The intent of the issue of digital information is to aid the related design by others. The definitive version of all drawings shall always be the paper or polyester film copies which have been issued by the Contractor or organisation originating the drawing.
- (3) Drawings and drawing packages issued for co-ordination, record purposes or for acceptance shall be accompanied by a complete set of the corresponding CAD data files.
- (4) Any Contractor or organisation making use of the CAD data from others shall be responsible for satisfying himself that such data is producing an accurate representation of the information on the corresponding paper drawing which is satisfactory for the purpose for which he is using it. Provided the general

principles of this section have been achieved by the originator of the CAD data, Contractors making use of the CAD data from others shall not be entitled to require alterations in the manner in which such CAD data is being presented to them.

- (5) In particular, automatic determination of physical dimensions from the data file shall always be verified against the actual figured dimensions on the paper or polyester drawings. Figured dimensions shall always be taken as correct where discrepancies occur.

3.4 Terminology & Associated Standards / Guidelines

Any terminology used within this section that is ambiguous to the user shall be clarified with the Engineer. British Standard BS1192 is used in principle as a guide for drawing practice, convention, CAD data structure and translation.]

3.5 Paper Drawings

- (1) Hard copies of the drawings, i.e. paper, are considered to be the main vehicle for the receipt and transmittal of design and production information, typically plans, elevation and sections.
- (2) The Project wide accepted media for the receipt and transmittal of “Paper” drawings will be paper and polyester film of various standard ISO ‘A’ sizes. The composition of this information shall be derived from a CAD “Model”, as noticed by the Engineer.
- (3) The CAD derived “Paper” drawing composition will reflect a window of information contained within a CAD “Model Space” file together with a selection of information contained within the associated CAD “Paper Space” file.

3.6 CAD Data Creation, Content & Presentation

A consistent method of CAD data creation, together with content and presentation is essential. The method of CAD “Model Space and Paper Space” creation is as follows:

- (1) Model Space Files
 - (a) Typically CAD “Model Space” files are required for general arrangement and location plans and will consist of a series of other “Model Space” referenced CAD files covering the total design extents at a defined building level (the number of referenced files should be kept to an absolute minimum). Data contained within a CAD “Model Space” files is drawn at full size (1:1) and located at the correct global position and orientation on the Project Grid (as noticed by the Engineer) / or defined reference points.
 - (b) Each CAD “Model Space” file will relate to an individual discipline. Drawing border / text, match / section lines or detailed notation shall NOT be included within a CAD “Model Space” file. Dimensions shall be included within a CAD “Model Space” but located on a dedicated layer. Elevations, Long Sections and Cross Sections shall also be presented in CAD “Model Space” as defined above, but do not need to be positioned and orientated on the Project Grid.
- (2) Paper Space CAD Files
 - (a) Paper Space” CAD files are utilised to aid the process of plotting “Paper” drawings and are primarily a window of the CAD “Model Space” file. A

“Paper Space” CAD file will typically contain drawing borders, text, match or section lines & detailed notation. Once these files are initially set up and positioned the majority of “Paper Drawing” plots at various approved scales are efficiently and consistently generated by displaying different combinations of element layers and symbology contained within the “Paper Space” file and the referenced “Model Space” files.

- (b) The purpose is to ensure that total co-ordination is achieved between the CAD “Model Space” file and the “Paper Drawing” output during the revision cycle of the design and production process. Duplicated data in “Model and Paper Space” files will not be acceptable unless an automatic update link exists between the two data sets. “Paper Space” files are not typically required as part of the CAD Media Receipt from Contractors, unless specifically requested by the Engineer.

3.7 CAD Quality Control Checks

- (1) Random CAD Quality Control Audits will be carried out by Engineer on all CAD media received and transmitted.
- (2) These checks DO NOT verify the technical content of the CAD data received or transmitted, as this is the responsibility of the originating organisation, however compliance with all CAD and Draughting Standards shall be checked.
- (3) In addition, all Contractors who transmit and receive CAD data relating to the Project shall have CAD quality control procedures in place. A typical quality control procedure shall contain CAD data quality checking routines coupled with standards for CAD data transmittal and archiving.

3.8 CAD Data Transfer Media and Format

When CAD data is received & transmittal between the Employer, the Engineer, the Contractor and Interfacing Contractors, the media shall be as follows:

- (a) Data Exchange Format - AutoCAD Release 21.0 or latest version .DWG
- (b) Operating System - Windows NT, Windows Vista or Windows 8.1 or Window 10
- (c) Data Transfer Media shall be submitted on DVD-RW Discs, of at least 4.0GB.
- (d) All DVDs must be labelled with a stick-on circular data sheet with the following details:
 - (i) Name of Contractor and/or Company
 - (ii) Project Title
 - (iii) Drawing Filenames
 - (vi) DVD Reference No. & Total No. of DVDs
- (e) All media shall be submitted with a completed Transmittal Form, refer to Attachment A2 of Section- A of this Section VI.
- (f) The Contractor must ensure the supplied media is free from all virus's, spam, shareware, etc...
- (g) Sub-directories on DVDs are not permitted. If CAD Data is created using UNIX, archive commands must be unrooted.

3.9 CAD Media Receipt & Transmittal

- (1) CAD Media Transmittal forms from the Contractor to the Engineer will consist of the following:

- (a) CAD Digital Media DVDs shall typically contain CAD “Model Space” and “Paper Space” files.
 - (b) CAD data sheet
 - (c) CAD issue / revision sheet
 - (d) CAD Quality Checklist confirming compliance.
 - (e) Plot of each “Model Space” file issued on an A1 drawing sheet (to best fit).
- (2) The above CAD media will be collectively known as “CAD Media Transmittal Set”. The CAD data file transmittal format required by the Engineer from all contractors shall be AutoCAD Version 21 or latest version.
- (3) All CAD media received from Contractors will be retained by the Engineer, as an audit trail / archive of a specific Contractor’s design evolution.
- (4) CAD Media Receipt, issued by the Engineer to the Contractor.
- (a) CAD media should normally be obtained from the respective Interfacing Contractor(s), but should the Engineer issue CAD media it will consist of the following :
 - (i) CAD Digital Media DVDs typically contain only CAD “Model Space” files.
 - (ii) CAD data sheet.
 - (iii) CAD issue / revision sheet
 - (b) The above CAD media will be collectively known as the “CAD Media Receipt Set”. The CAD data file transmittal format used by the Engineer to all Contractors will be in AutoCAD (version 21)
 - (c) Each CAD transmittal disk / tape will be labelled with proper disk label as approved by the Engineer. Any CAD data transmitted without this label is assumed to be provisional information not to have been quality checked and therefore not formally issued.

3.10 Revisions

- (1) All ‘Revisions’, ‘In Abeyance’ and ‘Deletions’ shall be located on a common layer. This layer can be turned on or off for plotting purposes.
- (2) The following example text indicates the current CAD file revision, i.e. ‘Revision [A]’. This shall be allocated to a defined layer on all CAD “Model Space” files, in text of a size that will be readable when the CAD “Model Space” file is fitted to the screen, with all levels on.

3.11 Block Libraries, Blocks, & Block Names

- (1) All Construction Industry symbols produced as CAD Cells shall typically conform to British Standard BS1192 - part 3.
- (2) All Blocks created shall be Primitive (i.e. NOT Complex) and shall be placed Absolute (i.e. NOT Relative).
- (3) The Contractor’s specific block libraries shall be transmitted to Engineer together with an associated block library list containing the filename (max. 6 characters) and block description. The Contractor shall ensure that the library is regularly updated and circulated to all other users, together with the associated library listing.
- (4) All Blocks of a common type, symbols or details should initially be created

within a CAD “Model Space File” specifically utilised for that purpose. These files will be made available on request by the Engineer.

- (5) All Blocks created will typically be 2D unless 3D is specifically requested. In both instances they shall have an origin at a logical point located within the extents of each Block’s masked area or volume.

3.12 CAD Dimensioning

Automatic CAD Dimensioning will be used at all times. Any dimensional change must involve the necessary revision to the model space file. If the CAD Quality Control Checks find that the revisions have not been correctly carried out, the rejection of the entire CAD submission will result.

3.13 CAD Layering

All CAD elements shall be placed on the layers allocated for each different discipline. The layer naming convention to be adopted by the Contractor shall be submitted for acceptance and inclusion within these standards.

3.14 Global origin, Location & Orientation on the Alignment Drawing.

- (1) Location or Plan information in “Model Space” files shall coincide with the correct location and orientation on the Project grid (as noticed by the Engineer) for each specific Contract.
- (2) Location plans shall have at least three setting out points shown on each CAD “Model Space” file. Each setting out point shall be indicated by a simple cross-hair together with related Eastings and Northings co-ordinates.

3.15 Line Thickness and Colour

To assist plotting by other users, the following colour codes will be assigned to the following line thickness / pen sizes.

Colour	Code No	Line Thickness
Red	10	0.18
White	7	0.25
Yellow	2	0.35
Brown	34	0.5
Blue	130	0.7
Orange	30	1.0
Green	3	1.4
Grey	253	2.0

3.16 CAD Utilisation of 2D & 3D Files

Although the project standard is 2D CAD files, certain disciplines and contractors may use 3D CAD files for specific applications or where the isolated use of 3D aids the design and visualisation process, i.e. Architecture, Survey and Utilities. In these specific instances 3D CAD data will only be transmitted if all other users can use this data. If this is not the case, a 3D to 2D translation shall be processed by the creator prior to issue.

3.17 CAD File Numbering

- (1) Contractors CAD File Numbering shall be as described in 2.1 above.
- (2) The Employer will not be required to produce numerous CAD files, but if they

issue any, the drawings shall follow the required Contract numbering system, except that the status of the drawing in clause 2.1(2) shall be "E".

3.18 CAD File Naming Convention – General

CAD “Model Space” files shall be named in accordance with general drawing conventions.

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PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 8 –Works Areas & Temporary Power Supply

June 2018

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WORKS AREAS & TEMPORARY POWER SUPPLY

1. INTRODUCTION

- (1) The Contractor shall provide within the designated principal Works Areas, at locations agreed with the Engineer, the compounds and facilities for the Employer, the Engineer, the Contractor and Project Contractors of the Employer as described elsewhere in this Contract and to the engineering conditions defined under Clause 2 of this Appendix 8.
- (2) The standard conditions applying to the use of any Works Area by the Contractor for its site facilities are given under Clause 2 of this Appendix.
- (3) The Conditions for supply of electricity by the Contractor to Interfacing Contractors are given under Clause 3 of this Appendix.
- (4) Other aspects of design, supply and construction within works areas, including structures within works areas shall be covered by the relevant parts of the Specification.

2. STANDARD ENGINEERING CONDITIONS

The following standard engineering conditions apply to all Works Areas:

- (1) Formation
 - (a) The Works Areas shall be formed to the levels that the Engineer has issued a notice for. No such levels shall be amended without a notice from the Engineer.
 - (b) The Works Areas shall be surfaced in a manner agreed with the Engineer, compatible with their intended use, and, in particular, footpaths and roadways connecting facilities shall be clearly defined. Measures shall be taken to the satisfaction of the Engineer to ensure all areas are properly drained and kept free of standing water.
 - (c) The removal, diversion or reinstatement elsewhere as may be required of any existing works or installation whatsoever within the Works Areas shall be carried out to the satisfaction of the Engineer.
- (2) Roads & Parking
 - (a) Space shall be provided within the Works Areas for parking, loading/unloading and maneuvering of motor vehicles.
 - (b) Any damage done to the adjoining public roads and fixtures and properties (public or private) shall be made good to the satisfaction of the Engineer.
- (3) Drainage & Sewerage
 - (a) All storm or rainwater from the Works Areas including any access roads thereto shall be conveyed to the nearest stream course, catch-pit, channel or storm water drain as required by the Engineer. All temporary and permanent works shall be carried out in such a manner that no damage or nuisance are caused by storm water or rain water to the adjacent property.
 - (b) No drain or watercourse shall be used without a notice issued from the Engineer.
 - (c) Damages or obstructions caused to any watercourse, drain, water-main

or other installations within or adjoining the Works Areas shall be made good to the satisfaction of the Engineer.

- (d) Treatment and disposal of sewage and wastewater from the Works Areas shall be provided to the satisfaction of the Engineer.
- (e) The clearance of Environmental Dept of Govt. of Maharashtra and other statutory authorities as applicable shall be obtained.

(4) Buildings

- (a) No permanent structures other than those required for the Permanent Works shall be temporarily permitted on the Works Areas.
- (b) Electricity, water, telephone and sewerage shall be provided by the Contractor, as required, for all temporary buildings.
- (c) No public supply potable water shall be used for heating, cooling and humidification purposes, or vehicle washing without a notice from the Engineer.
- (d) The clearance certificate from Electrical Inspector and other relevant statutory authorities as applicable shall be obtained.
- (e) The Fire clearance certificate from Fire authorities and other statutory authorities as applicable shall be obtained.

(5) Pedestrian Access

Every existing pedestrian access throughout the Works Areas shall be maintained in a usable condition at all times to the satisfaction of the Engineer including lighting, signing and guarding.

(6) Fencing

The Works Areas shall be secured against unauthorized access at all times. In particular fencing or the like shall be maintained, removed and re-erected in the new location wherever and whenever a Works Area is relinquished in stages.

3. ELECTRICAL SUPPLY CONDITIONS

3.1. Work on Site

- (a) The Contractor shall nominate a representative whose name and qualifications shall be submitted in writing to the Engineer for review not later than 4 weeks before the appointment and who shall be solely responsible for ensuring the safety of all temporary electrical equipment on Site. The Contractor shall not install or operate any temporary Site electrical systems until this representative is appointed and has commenced duties.
- (b) The name and contact telephone number of the representative having been reviewed with a notice of no objection by the Engineer shall be displayed at the main distribution board for the temporary electrical supply so that he can be contacted in case of an emergency.
- (c) Schematic diagrams and the details of the equipment for all temporary electrical installations shall be submitted by the Contractor, and these

diagrams together with the temporary electrical equipment shall be submitted to the Engineer for a notice.

- (d) All electrical installation work on Site shall be carried out in accordance with the requirements laid down in BS 7375 and the Specification. All work shall be supervised or executed by qualified and suitably categorised electricians, who are registered as such under the Electricity Ordinance 1990 / Electricity (Registration) Regulations 1990.

3.2. Electrical General

Temporary electrical Site installations and distribution systems shall be in accordance with:-

- (1) Indian Electricity Rules
- (2) The Power Companies' Supply Rules;
- (3) Electricity and its subsidiary Regulations;
- (4) IEE Wiring Regulations (16th Edition);
- (5) BS 7375 Distribution of Electricity on Construction and Building Sites;
- (6) BS 4363 Distribution Assemblies for Electricity Supplies for Construction and Building Sites; and
- (7) Any other applicable national standards

3.3. Materials, Appliances and Components

All materials, appliances and components used within the distribution system shall comply with BS 4363 and BS 7375 Appendix A and shall be inspected and approved by the Engineer before being used or operationalised at site.

3.4. Design Considerations

1. Distribution equipment utilised within the temporary electrical distribution system shall incorporate the following features:-
 - (a) flexibility in application for repeated use;
 - (b) suitability for transport and storage;
 - (c) robust construction to resist moisture, dust and damage; and
 - (d) safety in use.
2. All cabling shall be run at high level whenever possible and be firmly secured to ensure they do not present a hazard or obstruction to people and equipment.
3. The installation on Site shall allow convenient access to authorised and competent operators to work on the apparatus contained within.

3.5. Mains Voltage

1. The Site mains voltage shall be as per the Electricity Authority, 415V / 3 phase 4 wire system.
 - (a) Single phase voltage shall be as per the Electricity Authority, 240V supply.
 - (b) Reduced voltages shall conform to BS 7375.

2. Types of Distribution Supply

The following voltages shall be adhered to for typical applications throughout the distribution systems:

- a) fixed plant - 415V/ 3 phase, 50 Hz;
- b) movable plant fed by trailing cable - 415V / 3 phase, 50 Hz;
- c) installations in Site buildings - 240V/1 phase, 50 Hz;
- d) fixed flood lighting - 240V/ 1 phase, 50 Hz;
- e) portable and hand held tools - 240V/1 phase, 50 Hz;
- f) Site lighting (other than flood lighting) - 240V/1 phase; and
- g) portable hand-lamps (general use) - 240V/1 phase.

3. The required permissions from local Environmental Authorities/Pollution Control Board or any other relevant Authority shall be obtained by the Contractor for using DG sets for power supply.

4. Protection of Circuits

- a) Protection shall be provided for all main and sub-circuits against excess current, under and over voltage, residual current and earth faults. The protective devices shall be capable of interrupting (without damage to any equipment or the mains or sub-circuits) any short circuit current that may occur.
- b) Distribution and sub distribution electrical panels shall have a degree of protection not less than IP 65.
- c) Discrimination between circuit breakers, and fuses shall be in accordance with:-
 - i) BS 88;
 - ii) BS EN 60898; and
 - iii) BS 7375;
 - iv) Any other appropriate Indian Standards

3.6. Earthing

- 1. Earthing and bonding shall be provided for all electrical installations and equipment to prevent the possibility of dangerous voltage rises and to ensure that faults are rapidly cleared by installed circuit protection.
- 2. Earthing systems shall conform to the following standards:-
 - (a) IEE Wiring Regulations (16th Edition);
 - (b) BS 7430;
 - (c) BS 7375; and
 - (d) IEEE Standard 80 Guide for Safety in AC Substation Grounding.
 - (e) IS:3043

3.7. Plugs, Socket Outlets and Couplers

Low voltage plugs, sockets and couplers shall be colour coded in accordance with BS 7375, and constructed to conform to BS EN 60309. High voltage couplers and 'T'

connections shall be in accordance with BS 3905.

3.8. Cables

1. Cables shall be selected after full consideration of the conditions to which they will be exposed and the duties for which they are required. Supply cables up to 3.3KV shall be in accordance with BS 6346.
2. For supplies to mobile or transportable equipment where operation of the equipment subjects the cable to flexing, the cable shall conform to one of the following specifications appropriate to the duties imposed on it:
 - (a) BS 6708 flexible cables for use at mines and quarries;
 - (b) BS 6007 rubber insulated cables for electric power and lighting; and
 - (c) BS 6500 insulated flexible cords and cables.
3. Where low voltage cables are to be used, reference shall be made to BS 7375. The following specifications shall also be referred to particularly for underground cables:-
 - (a) BS 6346 for armoured PVC insulated cables; and
 - (b) BS 6708 Flexible cables for use at mines and quarries.
4. All cables which have a voltage to earth exceeding 65V (except for supplies from welding transformers to welding electrodes) shall be of a type having a metal sheath and/or armour which shall be continuous and effectively earthed. In the case of flexible or trailing cables, such earthed metal sheath and/or armour shall be in addition to the earth core in the cable and shall not be used as the sole earth conductor.
5. Armoured cables having an over sheath of polyvinyl chloride (PVC) or an oil resisting and flame retardant compound shall be used whenever there is a risk of mechanical damage occurring.
6. For resistance to the effects of sunlight, overall non-metallic covering of cables shall be black in colour.
7. Cables which have applied to them a voltage to earth exceeding 12V but not normally exceeding 65V shall be of a type insulated and sheathed with a general purpose or heat resisting elastomer.
8. All cables which are likely to be frequently moved in normal use shall be flexible cables.
9. The cables used shall be joint free. If a joint is unavoidable at certain location, the same shall be formed by skilled/certified person only and the material used for this purpose shall be subject to approval of the Engineer.

Flexible cables shall be in accordance with BS 6500 and BS 7375.

3.9. Lighting Installation

1. Where Site inspection of the Works is required during the nights, the Lighting circuits shall be run separate from other sub-circuits and shall be in accordance with BS 7375 and BS 4363.
2. Voltage shall not exceed 55V to earth except when the supply is to a fixed point and where the lighting fixture is fixed in position.

3. Luminaries shall have a degree of protection not less than IP 54. In particularly bad environments where the luminaries are exposed to excesses of dust and water, a degree of protection to IP 65 shall be employed.
4. The Contractor shall upgrade the lighting level to a minimum of 200 lux by localised lighting in all areas where required by the Engineer.
5. Mechanical protection of luminaries against damage by impact shall be provided by use of wire guards or other such devices whenever risk of damage occurs.
6. All light fixtures shall be fixed on appropriate pedestals when not fixed with mounting base on the structures.
7. The luminaries used shall be of LED type.

3.10. Electrical Motors

1. Totally enclosed fan cooled motors to BS 4999: Part 105 shall be used.
2. Motor control and protection circuits shall be as stipulated in BS 6164. Emergency stops for machinery shall be provided.

3.11. Inspection and Testing

Electrical installations on Site shall be inspected and tested in accordance with the requirements of the IEE Wiring Regulations (16th Edition).

3.12. Identification

Identification labels of a type reviewed with a notice of no objection by the Engineer shall be affixed to all electrical switches, circuit breakers and motors to specify their purpose.

3.13. Maintenance:

1. Strict maintenance and regular checks of control apparatus and wiring distribution systems shall be carried out by an electrician (duly qualified to carry out the said checks) to ensure safe and efficient operation of the systems. The Contractor shall submit for a notice by the Engineer details of his maintenance schedule and maintenance works record.
2. All portable electrical appliances shall be permanently numbered (scarf tag labels or similar) and a record kept of the date of issue, date of the last inspection carried out and the recommended inspection period.

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Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
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PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 9 – Railway Envelope Access and Control

June 2018

RAILWAY ENVELOPE ACCESS AND CONTROL

- (1) The Railway Envelope is defined in the Employer's Requirements - General.
- (2) The conditions pertaining to access to the Railway Envelope and its control are as follows:
 - (a) The Contractor shall complete the Works on the Key Dates defined in Appendix 2A of this Section VI – Employer's Requirements and allow the Employer/Engineer to Control the Access Over the Railway Envelope. From the date the Employer/Engineer starts exercising the control over the access to the Railway Envelope, any access to the Railway Envelope by the Contractor shall be in accordance with any procedures, requirements and conditions laid down by the Employer as defined under Clause 1(3) of this appendix.
 - (b) Before the Employer/Engineer starts exercising control over the access to the Railway Envelope, the Contractor shall have executed all necessary works on the structure and all other work within the Railway Envelope, including the installation of all equipment fixings defined within the Contract, and shall ensure that the Envelope is complete, secure, safe for the operation of trains, and has the Employer's and Engineer's notice of no objection for the same .
 - (c) From the date the Employer/Engineer starts exercising the control over the access to the Railway Envelope, any access to the Railway Envelope by the Contractor shall be in accordance with the conditions contained within clause 3 (below) of this Appendix.
- (3) The conditions for access to the Railway Envelope after the Employer/Engineer starts exercising control over the access to the Railway Envelope are as follows:
 - (a) Access to the Railway Envelope will be controlled by the Employer/Engineer and priority will be given to the testing and trial running of rolling stock and other operating components associated with the railway. Access will be given to the Contractor and to other Contractors by the Employer/Engineer for inspecting, maintaining, adjusting and repairing, by prior arrangement and for limited periods.
 - (b) Before the Employer/Engineer starts exercising control over the access to the Railway Envelope, the Contractor shall provide the Employer/Engineer with the name of an individual charged with liaising with the Employer/Engineer on a twenty-four (24) hour contact procedure. The Contractor shall give two weeks' notice of his desired track possessions, and this appointed liaison officer shall attend, when requested, the appropriate meetings where track possession allocations will be made by the Employer/Engineer. It may be necessary for the Contractor's work to be carried out intermittently or at night if suitable possessions cannot be given during its preferred hours. During all such operations the Contractor will be fully responsible for safety of men, equipment and works.
 - (c) After the access control over the Railway Envelope begins , and prior to the

completion of the Project, the Interfacing Contractors may be undertaking, but not limited to, the following activities:

- a. laying of tracks and other connected equipment .
- b. testing traction and signalling equipment together with other equipment and facilities required for operation of the railway. During this period the Employer and/or his contractors will be running works trains through the Railway Envelope
- c. undertaking acceptance tests, Integrated System Tests and test running: During this period the Employer and/or his contractors will be running trains through the Railway Envelope on a regular basis.
- d. undertaking trial running. During this period the Employer will be operating trains and equipment on a trial basis, the frequency of which will increase as the trials proceed until full operating frequencies are reached.

The Contractor shall take into account the Interfacing Contractors' activities and train operations in planning and programming his Works.

- (4) Prior to the issue of the Taking over Certificate for the Project, the Contractor will be given extended possessions of the Railway Envelope for the purposes of final adjustment, tightening, touching up or cleaning up prior to the final inspection of the Works. Such possessions shall be agreed with the Employer/Engineer in accordance with the procedure set out under Clause 1(3)(b) of this Appendix

2. RAILWAY EQUIPMENT

- (1) Non structural items.

Maintenance walkways within the Railway Envelope and any flooring, screens, handrails and exit doors forming the boundary of the Railway Envelope required in the terms of the Contract shall be supplied and installed by the Contractor before the Employer/Engineer intends to control the access to the Railway Envelope .

- (2) Electrical and Mechanical Equipment Fixings.

- (a) The Contractor shall be responsible for all co-ordination with the Employer/Engineer and Project Contractors for determining the detailed requirements for equipment fixing provisions in accordance with the Contractor's Works Programme.
- (b) No additional holes or welding to structural members beyond those shown on the Working Drawings, nor changes to hole or weld locations shall be permitted without the notice of the Engineer.

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Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

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Appendix 10 – Approved Manufacturers/Vendors

June 2018

LIST OF APPROVED MANUFACTURERS / VENDORS

All materials and products shall conform to the relevant standards/specifications of IS code, BS Code etc. and shall be of approved make and design. A list of manufacturers / vendors is given herein below for guidance. The approval of a manufacturer/vendor shall be given only after review of the sample / specimen by the Engineer. The complete system and installation shall also be in conformity with the – **“Applicable Codes, Standards and Publications”**.

List of approved makes for products and materials is given below. Other equivalent manufacturers may be considered with prior approval.

.No.	Details of Materials/Products	Manufacturer's Name
1.	Epoxy / Polyester resin For fixing anchor fasteners in soffits	<ul style="list-style-type: none">• “Lokset” of Forsoc Chemicals (India) Limited• STP MBT• Apple chemie
2.	Fire stop Sealant	<ul style="list-style-type: none">• Dow Corning's “Firestop Sealant 700: by• Universal Silicones Lubricants Pvt Ltd.• GE Silicone's Pensil 300 Fire stop Sealant”
3.	Ply wood	<ul style="list-style-type: none">• Uniply• Europly• Archidply• Century ply• Hunsurply• Corbett• Duroply (Green marked, BWR Grade) of Sarda Plywood Industries Ltd.,• Green Plywood Kitply
4.	Block board	<ul style="list-style-type: none">• Uniply• Euro Board• Green blockboard• Century board• Archid blockboard• Duroboard of Sarada Plywood• Bhutan Board

5.	Veneers	<ul style="list-style-type: none"> • Greenply • Euro make • Jackson • Timex • Legend • Sarda Plywood Industries Ltd.
6.	Burl Veneer	<ul style="list-style-type: none"> • Green • Euro make • Jackson • Venture Enterprise • Kitply Industries Ltd.
7.	Adhesive	<ul style="list-style-type: none"> • “Pidilite • Araldite • Jivanjor • Apple chemie • Don Construction Chemical Pvt Ltd
	Cement based Adhesive	<ul style="list-style-type: none"> • Ultratech
	Tiles adhesives	<ul style="list-style-type: none"> • Don Construction Chemical Pvt Ltd
8.	Flush Doors	<ul style="list-style-type: none"> • Kutty, • Karnataka State forest department, • Green, Decorative Duroply (Green marked), • Kitply
9.	Plastic Laminates	<ul style="list-style-type: none"> • Formica • Greenlam • Vir • Sundeck • Neoluxe • Bakelite Hylam
10.	Aluminium Sections	<ul style="list-style-type: none"> • Indian Aluminium Co. • Hindustan Aluminium / • Jindal, • Bhoruka
11.	Aluminium Composite Panel	<ul style="list-style-type: none"> • Flexibond • Alucobond • AluKbond • Eurobond • AlucoPanel • Viva
12.	Float Glass/Toughened Glass Insulating Glass	<ul style="list-style-type: none"> • Float Glass India Ltd • Modiguard • Saint Gobain

13.	Bevelled and Embossed Glass/Mirrors	<ul style="list-style-type: none"> • Gujarat Guardian Ltd. • Modi • Saint Gobain
14.	Powder Coatings	<ul style="list-style-type: none"> • Berger • Nerocoat • Jenson & Nicholson
15.	Asphalt Emulsion	<ul style="list-style-type: none"> • Karnak Chemical Corporation • STP
16.	Tile Joint Filler	<ul style="list-style-type: none"> • Bal Adhesives & Grouts • “Roff Rainbow Tile mate” of Roff construction Chemicals Pvt Ltd. • Winsil 20/Silicon Sealant of GE Bayer Silicon • “Zentrival FM” of MC-Bauchemie (IndiaPvt Ltd) • Apple Chemie • BASF
17.		<ul style="list-style-type: none"> • Kajaria Ceramics Limited • Arpitha Exports
18.	Heavy Duty Chequered Tiles	<ul style="list-style-type: none"> • NITCO • Modern Tiles
19.	Ceramic Tiles	<ul style="list-style-type: none"> • Kajaria • Bell • Spartek • Goldcoin • Johnson • Somany • RAK Ceramics • Murudeshwar Ceramics
20.	Vitrified Tiles	<ul style="list-style-type: none"> • “Naveen Diamontile” of Murudeshwar Ceramics Ltd. • “Granamite” of Restile Ceramics Limited • “Marbo Granit” of Bell Granito Ceramica Ltd • Johnson Tiles • Somany Tiles
21.	Marble blended Vinyl Tiles/Sheet	<ul style="list-style-type: none"> • Armstrong of Inarco Ltd • Terkett Floorings • Krishna Vinyl

22.	Glass Mosaic Tiles	<ul style="list-style-type: none"> • Mridul Enterprises • Italia • Palladio
23.	Marble Mosaic Tiles	<ul style="list-style-type: none"> • Nitco • Basant Tiles
24.	Aluminum Linear Ceiling	<ul style="list-style-type: none"> • Luxalan • Interarch • J C Industries • Hunter Douglas • Fundermax • Armstrong
25.	Steel Panel Ceilings	<ul style="list-style-type: none"> • Interarch • Armstrong • Metckaft
26.	Resin Bonded Glass Wool	<ul style="list-style-type: none"> • Rockloyd • Kingsway • LLYOD Insulations (INDIA) Ltd.
27.	MS Tubes	<ul style="list-style-type: none"> • Tata • Lloyd Metal & Engineering Co. • NSL Limited
28.	Modified Bituminous	<ul style="list-style-type: none"> • “Multiplas Standard” of Integrated Waterproofing Membrane Limited • “SUPER THERMOLAY”/”POLYFLEX’ of STP Limited . • “LOTUS-3” of the Structural Waterproofing Co. Limited • “HEAVY DUTY POLYPLY” of Ana Roofings Private Ltd • Apple chemie • Shell • Hincola
29.	Epoxy Putty	<ul style="list-style-type: none"> • “Techoxy” by Choksey Chemicals Pvt Ltd. • Apple chemie
30.	Polysulphide Sealants	<ul style="list-style-type: none"> • Pidilite Industries Ltd . • STP • Fosroc • Choksey • Apple chemie

		<ul style="list-style-type: none"> • Supreme Bituchem India Pvt. Ltd.
	Polyurethane sealant	<ul style="list-style-type: none"> • Supreme Bituchem India Pvt. Ltd
31.	Silicone Sealants	<ul style="list-style-type: none"> • G.E. Bayer Silicone • Dow Corning • Waclear
32.	Sealant Joints	<ul style="list-style-type: none"> • Watson Bowman Acme Corporation • “Silpray” of G.E. Bayer Silicare • Don Construction Chemicals pvt ltd
33.	Paints	<ul style="list-style-type: none"> • I.C.I. • Berger • Jonson & Nicholson • Asian Paints • Dulux • Nerolac • Surfa
34.	Emulsion Paint	<ul style="list-style-type: none"> • ICI • Dulux Velvet • Luxol Silk • Jonson & Nicholson • Asian Paints • Dulux • Nerolac • Surfa
35.	Synthetic Enamel	<ul style="list-style-type: none"> • I.C.I. • Berger • Jonson & Nicholson • Asian Paints • Dulux • Nerolac • Surfa
36.	Texture Paints	<ul style="list-style-type: none"> • Spectrum • Unitile • Surfa • Birla
37.	Polyurethane Paint	<ul style="list-style-type: none"> • MRF • Berger

38.	Wax Polish	<ul style="list-style-type: none"> • Reckitt & Colman • Asian • Berger
39.	Melamine	<ul style="list-style-type: none"> • ICI Delux Timberstone Melamine Coating • Asian / • Berger
40.	Membrane Water Proofing	<ul style="list-style-type: none"> • Padmaja Engineering Services, INC • Bitumat • Apple Chemie • Supreme Bituchem India Pvt. Ltd • Don Construction Chemicals pvt ltd
		<ul style="list-style-type: none"> • BASF • Pidilite • Hindcom Chemicals Limited
	Cement based water proofing	<ul style="list-style-type: none"> • Ultratech
41.	Cement Bonded Particle Board	<ul style="list-style-type: none"> • Bison Panel Board • Everest Industries
42.	Stainless Steel Railings	<ul style="list-style-type: none"> • Salem Steel • Jindal Stainless steel • GM 2 metal works • Entarchcon Infratech Pvt. Ltd.
43.	Raised (Access) Floor / Cavity floor	<ul style="list-style-type: none"> • Hewetson • United Insulation • Proactive Systems • Universal Infrastructure Systems
44.	Fire Check Doors	<ul style="list-style-type: none"> • Godrej • Shakthi Hormann Pvt.Ltd.
45.	Pressed Steel Door Frames	<ul style="list-style-type: none"> • Deccan Structural Systems Pvt. Ltd, • Agew • San-Harvic
46.	Ceramic Claustra	<ul style="list-style-type: none"> • Scindia Potteris
47.	Interlocking Paving Tiles	<ul style="list-style-type: none"> • Pavestone Marketing Pvt Ltd • Nitco Marble & Granite Pvt. Ltd
48.	Ashford Formula	<ul style="list-style-type: none"> • JB Associates
49.	Eleganstone	<ul style="list-style-type: none"> • Bubna Commodities (P) Ltd
50.	Roc Wool	<ul style="list-style-type: none"> • Lloyd Insulation (India) Ltd • ROCKWOOL

51.	Cavity Block	<ul style="list-style-type: none"> • Apco Concrete Block • Besser Concrete Systems Ltd • Sobha Concrete Products
52.	AAC Blocks	<ul style="list-style-type: none"> • Hyderabad Industries Ltd • Ballarpur Industries Ltd • Ultratech
53.	Cement concrete designer tile	<ul style="list-style-type: none"> • Eurocon tiles, • Duracrete • Ultra tiles.
54.	Polycarbonate sheets	<ul style="list-style-type: none"> • GE Plastics (Lexan) • Tuflite
55.	Iron Mongery	<ul style="list-style-type: none"> • Dorma • Ozone
		<ul style="list-style-type: none"> • Kich • Yale • Dorset • Henderson • Ebco
56.	AAC Block joint adhesive	<ul style="list-style-type: none"> • Ultratech • Apple Chemie
57.	Readymade Plastering	<ul style="list-style-type: none"> • Ultratech • Apple Chemie
58.	Cement base grouting	<ul style="list-style-type: none"> • Ultratech • Apple Chemie • BASF • Supreme Bituchem India Pvt. Ltd • Don Construction Chemicals pvt ltd
59.	Baffel Celing	<ul style="list-style-type: none"> • Armstrong • Hunter Douglas
60.	Exterior cladding	<ul style="list-style-type: none"> • Hunter Douglas • Fundermax
61.	Perforated metal ceiling	<ul style="list-style-type: none"> • Hunter Douglas • Fundermax • Armstrong
62.	Glass Dome	<ul style="list-style-type: none"> • Entrachcon Infratech Pvt. Ltd.
63.	Tensile Roofing	<ul style="list-style-type: none"> • Saint Gobain
64.	Roof Latches	<ul style="list-style-type: none"> • LATCHWAYS
65.	AL Roof Vents	<ul style="list-style-type: none"> • Agaris Airvent Systems

66.	Roofing 1. Galvalume 2. Zinalume	<ul style="list-style-type: none"> • Tata Blue Scope • JSW Steel • LLYOD Insulations (INDIA) Ltd. • VM Zinc • VIJAYANATH • LLYOD Insulations (INDIA) Ltd. • Tata Blue Scope
67.	Toilet Cubicles	<ul style="list-style-type: none"> • Macro Enterprises
68.	Tactile Flooring	<ul style="list-style-type: none"> • Johnson Tiles
69.	CEM Board	<ul style="list-style-type: none"> • USG Boral • NCL

70.	Calcium Silicate Board	<ul style="list-style-type: none"> • Promat
71.	AL windows & Glazing	AJIT INDIA (Madras) Pvt. Ltd.
72.	Cement	ACC, Ultratech, Gujarat, Ambuja, Grasim, JK Lakshmi
73.	Reinforcement Bars	SAIL Plants, Rashtriya Ispat Nigam Ltd. Vizag Steel Plant, , Tata Steel , Ispat Industries , JSW Steel , JSPL, Essar Steel , Electrosteel steels limited (for use in non-dynamic structure)
74.	Epoxy	FOSROC, SIKA QUALCRETE, Araldite, BASF
75.	Expansion Joints	Prequalified Manufacturers as per RDSO's latest approved list or as approved by NMRCL.
76.	Admixtures	FOSROC, MBT. MC Baucheme, Sika, APEX, Pidilite, BASF
77.	Pile Integrity Testing Agency	CBRI. Pile Dynamic. AIMIL, Geo dynamic.
78.	Anchor Fastener	HILTi. FISHER, BAUCH
79.	Structural Steel	TATA, SAIL, ESSAR, Jindal Steel & Power Ltd, JSW
80.	Stainless Steel	Jindal. SAIL
81.	Pre-stressing Strand (LRPC)	TATA SSL Ltd, USHA Martin,
82.	Welding Electrodes	ESAB. Advani - Orlikon Weld Alloy. Modi L&T Eutectic,
83.	Pot/Elastomeric Bearings	Prequalified Manufacturers as per RDSO's latest approved list
84.	Horizontal Tie Bars/Shear Bars	BB Bars System, BBV Systems ,Dextra

85.	HDPE Sheathing	Rex Polyextrusion, Gwalior Polypipes Ltd, M/s Dynamic Prestress
86.	Formwork Release Agent	FOSROC, MBT, MC Baucheme, Ado Conmat, CICO, SWC, Choksey, BASF, Adoadditives, STP
87.	Prestressing System	Freyssinet, BBR, VSL, Dynamic, Killick Nixon, Tensacciai (India Ltd.), Usha Martin, Posten, VSIL
88.	Reinforcement Couplers	Dextra, Moment
89.	Hollow Sections, Pipes	Surya Pipes, Hi-Tech Pipes, JSW, JSPL,
90.	Drainage Pipes	Tirupati Plastomatics, Duraline, REX, STIPL
91.	Acrylic Textured Coatings	Spectrum, Renova, Wallz, Surfa Nova, Jotun, Asian Paints
92.	Non shrink Grout	Fosroc Chemical (India). SIKAS BASF, ELCHEM, MBT. Sika.
93.	Bonding Coat	CICO, FOSROC, Sunanda speciality coating Pvt. Ltd., BASF, SWC. TAM
94.	Polysulphide Sealant	CICO. Pidilite. BASF. FOSROC. SWC, STP, SIKAS, Fairmate
95.	Steel Structural Fasteners	Pooja Forge, Sundram Fasteners, Unbrako, Nelson, Panchsheel
96.	Paints	Berger, Johnson Nicholson, Nerclac, Asian,
97.	Micro Silica	Sika, Elkem, FOSROC. MAPEI. Comiche, Star Silica, TAM, CALIPAR, CICO
98.	Fire Resistant Paints	Akzo Noble, PPG or equivalent, Jotun
99.	External Acrylic Emulsion	Berger, Apex, Asian, Nerolac, Jenson & Nicklson
100.	Integral Crystalline Waterproofing Method	Don Construction Chemicals pvt ltd
101.	Water stopper/Bar	Kanta Rubber. Greenstreak, Maruti, Duron
102.	Liquid polymer membrane waterproofing	INTEGRITANK, BASF. MAPEI, PIDILITE. DAVCO, CICO, Supreme Bituchem India Pvt. Ltd
103.	Curing Compound	Clean tech concure, SINAK, FOSROC, Ado additives, TAM, STP SWC.CICO, Rheoplast Technologies pvt. Ltd.
104.	Polycarbonate Sheets	M/s Gallina Acroplus. Coxwell, Poly U, Fabric, SABIC I.DANPALON
105.	Fly ash	Thermal plant. Ashcrete, Ultra pozz, star pozz, (the fly ash shall be as per our specifications)
106.	False Ceiling	Hunter Douglas

107.	ACP	Hunter Douglas, Durobuild
108.	Aluminum Louvers	Hunter Douglas-LUXALON H-3 , CS-RS-1605
109.	SS Railing	Sanvijay
110.	Barbed Wire / Chain-link fencing	Krishna Industries Bhilwara, / Concertina Coils New Delhi,
111.	PEB/Steel Structures/Pipe Structure	TT, Framecad, Voltagreen, Everest, ZAMIL
112.	Cement (For Brick Works, & General Work, Wall/Boundary Wall only)	Birla Gold (Manikgarh Cements)
113.	MS Angles & Flats	Ramson Steel (For general purpose only, not for dynamic & heavy loading structures)
114.	Corrosion Inhibitors -	Krishna Conchem Product Pvt. Ltd.
115.	Coal tar epoxy for sub-structure protection.	Krishna Conchem Product Pvt. Ltd.
116.	Porotherm lightweight clay hollow block/bricks	Wienrberger Bangalore
117.	Fibrillated polypropylene fibers	Bajaj Steel Industries Limited (for non-dynamic structure)
118.	Pre Engineering Building Pre fabricated Structural steel	M/S Kirby Building India Ltd
119.	Cold Rolled, Galvanized, Galvalume, Color Coated, HRPO, HRSP, Plain, Corrugated, Profilled, Sheets and Coils	M/s JSW Steel Coated Product Ltd
120.	Centrifugally Cast (Spun) iron pipes and fittings as per IS 15905 & ISO 6595 standards. Centrifugally cast iron pipes and fittings as per IS 3989 specifications. Ductile iron manhole covers, frames & gratings as per EN-124 standards. Cast iron manhole covers, frames & gratings (ISI Marked) as per IS: 1726.	M/S Jayaswal Neco Industries Ltd
121.	Aluminium Composite. Aluminium Colour Coated Coils.	M/S Alstrong Enterpsies Pvt. Ltd

122.	Pre Engineering Building, Pre Fabricated Structural Steel Grade	M/S PHENIX Construction Technologies(A Division Of M&B Engineering Limited)
123.	Waterproofing Membranes	M/S Tiki Tar Danosa (India) Private Limited
124.	Fire rated Steel Doors, Fire rated timbers Doors ,Fire Barriers, Fire rated Sliding Doors and Fire rated Rolling Shutters	M/S Signum Fire Protection India PVT Ltd
125.	ALCCOFINE 1203 Micro fine additive for concrete and mortars	M/S Counto Microfine Products Pvt Ltd
126.	Profiling of Galvanized and Colour Coated Roofing and Decking Sheet from approved Manufactures of sheets	M/S Aditya Profiles Pvt Ltd
127.	Manual Metal Arc Welding (MMAW) Electrodes	M/S Weldfast Electrodes Pvt Ltd
128.	MS ERW Black, Galvanized Round Pipes Hollow Sections	M/S APL Apollo Tubes Limited
129.	Manhole Covers, Gully Covers, Overhead water tank covers, Underground water tank covers & Gratings	M/S HP International
130.	Chemical Anchoring FriuIsider Mechanical Anchoring System	M/S Ripple Construction Products Pvt Ltd
131.	Bronze and Brass gate Globe check strainers and ball valves and ductile iron and Aluminium Butterfly valves	M/S Kitz Corporation
132.	Steel Wire Ropes	M/S ORION ROPES Pvt Ltd
133.	Pre Engineered Structures and Structural Steel	M/S Apex Buildsys Turnkey Solution
134.	Industrial and decorative Paints, Powder Coating, Emulsion Paint, Synthetic Enamel and Polyurethane Paint	M/S Kansai Nerolac Paints Limited

135.	SHELLOXY-Crack bridging, decorative, flexible, anti-carbonation and waterproofing coating for concrete SUPER SHIELD SELFPROTEK – Heavy Duty ,Cold applied, self adhesive water proofing membrane with HMHDPE laminated for electric insulation	M/S Supreme Bituchem India Pvt Ltd
136.	Rerolling of steel section, column section , Wide flange beam, channel section ,angle section for Non Dynamic Structures	M/s Shri Bajrang Alloys Ltd.
137.	Hot Rolled Structural Steel , Beam - 200mm to 600mm, Channel- 200mm to 600 mm ,Angle -130 mm to 200 mm and H-Beam -150 mm to 200 mm for Non Dynamic Structures	M/s Topworth steel &power Pvt Ltd.
138.	Pre Engineered Building (Steel Column & steel Roof)	M/s Richa Industries Ltd.
139.	Integral waterproofing compound, Wall putty, Floor hardeners, Grouts for machine foundation, Epoxy bonding agent and structural repair product	M/s Perma Construction Aids Pvt Ltd.

140.	Expansion joints, Epoxy Formwork Release Agent , Segment Bonding Agent , Acrylic Textured Coating, Bonding Coat or Bonding Agent, Polysulphide Sealant, Water Stopper /Bar, Liquid Polymer membrane Waterproofing, Curing Compound, Waterproofing Systems, Polymer	M/s Fair Mate Chemicals Pvt Ltd.
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The above list is not exhaustive. Contractor may proposes similar product of other reputed vendor too for the works. However the approval /acceptance / rejection of proposed vendor rest with NMRCL.

Vendor List for MEP Works

Sl. No.	Item	Proposed vendor List for NMRCL
Vendor List for Electrical items:		
1.1	MS/GI Conduits ISI embossed black enamelled / galvanized	AKG BEC,
1.2	MS/GI Conduit accessories superior type as per approved samples	Sharma Sales Corporation Super Sales Corporation
1.3	PVC rigid conduit and accessories ISI embossed	BEC, AK
1.4	PVC flexible conduit and accessories	PMA-SSK
1.5	MS Raceways and raceway accessories.	V K Industries Steelways
1.6	Cable trays & Cable ladder	Indo Asian Profab Patny Innospace Rattan Omcara Emco Mahaveer,kalkatta Technofab Engineers Sunrise Electrical Industries M K Industries Sai Cable Tray Pinnacle metals
2	Wires, cables and cable accessories	
2.1	Wires	
2.1.1	1100 volt grade FRLSZH /FR PVC insulated stranded copper conductor wires	Finolex Polycab Bon Ton KEI RR cable Anchor RPG Universal Leoni Lapp
2.2	1100 volt grade Cables	
2.2.1	1100 volt grade ,armoured, XLPE FRLSZH/Fire Resistant cable, Copper/Aluminium Conductor cables	Poly cab Havells Finolex KEI RR cable Anchor RPG Universal Leoni

		Lapp Cords Rallison Govind cables
2.3	Cable Accessories	
2.3.1	1100 volts Doubles compression brass cable glands	Dowells, Peeco, Comet Siemens
2.3.2	1100 volts Doubles compression PVC cable glands	Trinity Touch (Jacob)
2.3.3	1100 volt Cable lugs	Dowell's (Biller India Pvt. Ltd)
2.3.4	Terminal blocks & cage clamps	ELMEXX, PHOENIX, WAGO, Connectwel
3	Wiring accessories	
3.1	Modular grid plate wiring accessories (switches, socket outlets bells etc.) with boxes.	Siemens Honeywell Wraparound Plus Legrand Mosaic
3.2	Metal clad Socket Outlets with boxes	Anchor MK Legrand Crabtree
3.3	Under floor junction boxes and cable management system	Legrand
3.4	Weather Proof plugs and sockets (IP 65 / 66)	Neptune Legrand
4.	Distribution equipment	
4.1	Switchgear	
4.1.1	MCB's/RCCB's	L&T, GE, ABB, Siemens, Schneider, Merlin Gerin
4.1.2	Earth leakage circuit breaker	L&T, GE, ABB, Siemens, Schneider, Merlin Gerin
4.1.3	Timers in Distribution Boards	L&T, GE, ABB, Siemens, Schneider, Merlin Gerin
4.1.4	Distribution Boards	Schneider Siemens Legrand Lexic
4.2	Circuit Breakers	
4.2.1	Moulded Case Circuit Breakers, Motor protection circuit breaker	L&T, GE, ABB, Siemens, Schneider, Merlin Gerin
4.2.2	Switch Fuse Units and Isolators	L&T, GE, ABB, Siemens, Schneider, Merlin Gerin
4.2.3	Change over switch / Isolators	L&T HH Elcon
4.2.4	Air Circuit Breaker	L&T, GE, ABB, Siemens, Schneider, Merlin Gerin
4.2.5	Automatic transfer switch (ATS)	Tricolite ASCO Cummins Socomac
4.2.6	Power/auxiliary, Capacitor control Contactors, overload relays	L&T, GE, ABB, Siemens, Schneider, Merlin Gerin
4.2.7	MPP heavy duty Capacitors	Siemens (Epcos), Neptune Ducati
4.3	Accessories	

4.3.1	Protection relays electromechanical	Areva, ABB, L&T,
4.3.2	Protection Relays Numeric	Areva, ABB, Siemens
4.3.3	APFC relay 3 phase	L&T, Ducati Neptune Conzerv,
4.3.4	Single phase preventer, overload relays	Siemens ABB, Schneider Electric,
4.3.5	Current Transformer	Gillbert & Maxwell, Precise, AE,
4.3.6	Control / Potential Transformer	Gillbert & Maxwell, Precise, AE
4.3.7	Push Buttons, Indicating lamps LED	L&T, GE, Siemens, Schneider,
4.3.8	Selector switches	L&T, Siemens,
4.3.9	Instruments – analogue	L&T Rishab, AE,
4.3.10	Digital meters	L&T, Schneider,
4.3.11	Power and harmonic analyzer	Conzerv Secure Neptune Ducati
4.3.12	Programmable Logic Controller (PLC)	Allen Bradley, Siemens
4.4	LT 415 volt switchboards	
4.4.1	Main LT switchboards PLC Panels Capacitor Panels Floor LT panels	Dricolite, EMCO Switchgear, Power control, Bajaj, Lotus, Pragathi control, Pyrotech
5.	Bus Trunking	
5.1	Lighting Bus Trunking	Dricolite, EMCO Switchgear, Power control, Bajaj, Lotus, Pragathi control, Pyrotech
6.	Light Fixture & Accessories	
6.1	Light fittings	Philips, Wipro, GE
6.2	Area Lighting Masts	Wipro, Philips, GE
6.3	Circulator fans/exhaust fans	Crompton Greaves, Orient, Khaitan, Almonard

6.4	Lighting Control system	Hubbell, Dynalite, Wipro
6.5	Ceiling Fans	Crompton Greaves, Orient, Khaitan
6.6	LED	Nichia, Lumileds, Citizen, Cree, LG
7.	UPS System	
7.1	UPS System	Emerson Delta Socomac Hireal
7.2	UPS Battery	Exide, Farukawa, Standard, Aamaraja
8.	Miscellaneous Sub Station equipment	
8.1	Rubber mats	
8.2	CO2 Fire extinguishers	Fire Traces Tyco
8.3	Battery banks maintenance free VRLA	HBL Nife Exide, Amar Raja, Standard Furukawa
8.4	Battery charger	HBL Nife AE Caldyne, Amar Raja
9	Miscellaneous	
9.1	Anchor Fastener	Hilti, Fisher
9.2	Welding rods	Advani Oerlikon L&T
9.3	Paints	ICI, Asian, Shalimar
9.4	Fire sealing material	Hilti Birla 3M Roxtec
10	BMS / SCADA	GE Honey well Mitsubishi Siemens Rockwell Automation ABB
11	DG SET	Sudhir Powerica Mahindra Jackson
Vendor List for Fire Fitting Systems:		
1	Fire hydrant valves	Inter Valves Lehary Kartar Zotoisi

		Sant
2	Piping	TATA ,Jindal, Apollo,Values
3	Fire hose pipes with Stainless Steel coupling	New Age Ind. CRC Jayshree
4	Rubber hose reel	Jyoti Maruti
5	First aid fire hose reels	
6	Fire extinguishers	Minimax Safex
7	Sprinkler heads	
	(a) Sidewall type	
	(b) Sprinkler intelligent (auto start / shut)	Tyco Reliable Grinnell
8	Horizontal centrifugal pumps	Kirlosker WILO KSB Grundfos Becon CRI
9	Electric motors	Siemens, KEC, CGL
10	Electrical switch gear & starter	As per electrical works
11	Cables	As per electrical works
12	Flow switch	System Sensor, Potter
13	Suction strainer	Leader / Zoloto
14	Vibration eliminator connectors	Resistoflex
15	Fire alarm detectors	Edwards Notifier
16	Panel Flooding(CO2)	FireDe Tech Fire Traces
Vendor list for HVAC System		
1	VRV Unit	Toshiba Blue star Voltas Daikin Mitsubishi
2.	Fans	Flakt, Kruger, System Air, Marathon
3	Grille/diffuser and fire damper	Caryaire, Ravistar, Air Flow
4	Factory fabricated ducting	Rolastar, Zeco,Techno Fabriduct

5	Fiber glass Insulation	UP Twiga, Kimco, Owns Corning
6	Anchor Fasteners	Hilti, Fischer
7	MS/GI Conduits ISI embossed black enamelled / galvanized	As per Electrical works
8	Cable trays & Cable ladder	As per Electrical works
9	1100 volt grade XLPE Insulated Aluminium Conductor cables	As per Electrical works
10	1100 volts Doubles compression brass cable glands	As per Electrical works
11	MCB's/RCCB's	As per Electrical works
12	Moulded Case Circuit Breakers, Motor protection circuit breaker	As per Electrical works
13	Main LT switchboards PLC Panels Capacitor Panels Floor LT panels	As per Electrical works
14	Electrical motors	CGL, Siemens, KEC
15	Welding rods	Advani Oerlikon, L&T

Vendor list for Public Health Engineering

1	Sanitary Fittings	Parryware Jaquware Hindware
2	Water Cooler	Blue star Daiken Volts
3	Water heater	Bajaj Smith
4	Piping	TATA Jindal

		Apollo Values
5	Horizontal centrifugal pumps	Kirlosker WILO KSB Grundfos Becon CRI
6	Valves	Inter Valves Lehary Kartar Zotoisi Sant

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Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 11– Curve and Gradient Details

June 2018

CURVES AND GRADIENT DETAILS

Horizontal and Vertical Alignment

All details with regard to the Horizontal and Vertical Alignment are shown on the plan and profile sheets of the Employer's Drawings provided in Section IX of the Contract.

The amendments to the alignment shall be made only in accordance with and under the circumstances as stipulated in the Contract documents. No amendment shall be made to the alignment without a Notice of No Objection from the Engineer.

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Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 12 – Utilities

June 2018

UTILITIES

DEFINITIONS

Utilities-

Utilities are defined as public utilities above or below ground and include all live water mains, water wells, power cables, street lights, transformers, telephone posts, telecommunication cables, sewers, storm water drains and the like shown on the Employer's Drawings OR are uncharted and are therefore not shown on the Employer's Drawings.

Charted Utilities-

Charted Utilities are the utilities (as defined above) which are shown on the Employer's Drawings.

Uncharted Utilities-

Uncharted Utilities are the utilities (as defined above) which are not shown on the Employer's Drawings.

Responsibility of the Contractor.

1. The Contractor shall make his own enquiries and investigations, including excavating trial holes/pits, to ascertain the existence, nature, location and size of utilities. A schedule of utility diversions and utilities to remain but to be supported /protected (the utility diversion plan) shall be prepared by the Contractor and submitted with the Preliminary Design. The schedule will list out utilities that:
 - will be diverted by the Contractor during the course of the Works, and
 - will remain in place and require the use of specific construction protection methods to complete the underground structures around and below the utilities including support/protection of the utilities during construction.
2. The Contractor shall take into consideration the time required for utility diversions into the overall Works Programme for the Contract. However, efforts shall be made to avoid diverting/disturbance of any utility and continue the Works by supporting/protecting the same but the required services being provided by these utilities shall be maintained at all the times at the cost of the Contractor.
3. The diversion work shall be undertaken by the Contractor as per the approval of the Utility owning Agencies and a notice from the Engineer. Temporary supports and protection by methods proposed by the Contractor and agreed by the Utility Agency and Engineer shall be provided to the utilities. Permanent supports and protection shall be provided wherever required for the safety and security of the utility service.
4. The Contractor shall immediately inform the Engineer and the Utility Agencies of any
 - (a) damage to utilities;
 - (b) leakage of utilities;
 - (c) discovery of utilities not previously identified;
5. When diverting and/or protecting sewerage and stormwater lines the Contractor shall ensure that drainage to the site and adjacent areas is maintained at all times and that at no times flooding or other nuisance occurs.
6. The Contractor shall inform the Engineer of the programme of all works of utility diversion/ protection works and shall take all steps to enable the utility diversions to proceed in accordance with the programme. The Contractor shall maintain close liaison with the Utility

Agencies. The Contractor shall set up and manage a Utility Liaison Group of experienced personnel for the duration of the Contract.

7. Records of the existing utilities encountered shall be kept by the Contractor on the Site and a copy provided for the Engineer. The records shall contain the following details :
 - (a) location of utility;
 - (b) date on which the utilities were encountered;
 - (c) nature and sizes of the utilities;
 - (d) condition of utility;
 - (e) temporary or permanent supports provided; and
 - (f) Diversions made – Temporary or permanent
8. The Contractor shall include the details (plan, location, ownership, size and material) of all such utilities on the As Built Drawings.

Diversion and Protection of Underground/Overhead Utility Lines

9. The work comprises of replacement, relocation, diversion and protection of existing sub-surface, surface and overhead public utilities viz. sewer mains, water lines, water wells, storm water drains, gully pits including connection pipes, house drains, gas pipe lines, electric and telephone cables, optical fibre cables including their appurtenance structure, O.H. electrical transmission line, electric poles, traffic signals, etc... which will be disturbed due to construction of the metro stations, shafts and tunnels, where applicable.
10. The Contractor shall divert and/or effectively protect all public utilities falling within the metro station, Cut & Cover Ramps and shaft locations and their immediate adjoining areas or which are likely to be exposed, disturbed or damaged during the execution of the work or in consequence thereof, in such a manner and using such materials as required or specified by the concerned public Utility Agencies and as per instruction of the Engineer, and hold them in proper position without any damage being caused to them during execution of work. Where adequate space is not available adjacent to the footprints of the proposed stations, the utilities may have to be diverted within the station-box itself to facilitate the construction of diaphragm/secant piles wall.
11. The Contractor shall have to bear the expenses of providing and laying pipes, water wells, gas mains/gully pit connections/house drains and other electric, telephones, optical fibre cables and other cables including their appurtenance structure, O.H. Electrical transmission line, electrical poles, traffic signals or any other underground structures or services falling within the metro station, shaft and tunnel locations, and their immediate adjoining areas which may be found to have been disturbed or damaged due to the Contractor's fault and/or defective and careless workmanship. The decision of the Engineer in this respect shall be binding and final and all costs of rebuilding or repairing of such damaged services or structures as aforesaid shall be deducted from the Contractor, if the same is not taken care of within a time frame, as directed by the Engineer.
12. The Contractor shall enquire of and collect information from all concerned public Utility Agencies, owners, Government Departments and local bodies in connection with the sewer lines, water mains, water wells, cables, wires and any other obstruction either overhead or on ground or underground which may be encountered in the course of execution of the work and which are likely to affect the progress of the work, at his own cost and risk. No idle labour charge will be admissible on account of delay in collecting the above-mentioned information.

13. The Contractor shall have to excavate trial trenches of suitable sizes for satisfactorily exploring all the underground utilities as required and as instructed by the Engineer before commencement of any work below ground level.

The time of completion for the project is inclusive of diverting and/ or protection (temporary as well permanent) of utilities.

Additional Conditions for Diversion/Protection of Utilities above Underground Stations/Shfts

14. It is the responsibility of the Contractor to get the approval of the proposed water/sewer/storm water/ pipeline etc diversion/shifting from PMC or the concerned Agency/Authority. However PMRP will facilitate the co-ordination work with PMC/concerned agency for getting the necessary approval.
15. In case the concerned utility agency/authority maintains a list of registered/approved contractors for undertaking such works and desires such shifting/diversion of pipeline/utility etc work to be undertaken by such registered/approved contractors, then such shifting/diversion of pipeline/utility etc shall have to be carried out by engaging the registered/approved contractors .
16. In case the Engineers of PMC /concerned agency intend to supervise the work, the Contractor (or sub-contractors engaged by the Contractor) have to carry out the work as per the instruction of the PMC /concerned agency's Engineers during diversion work by the Contractor.
17. In case of permanent diversion of water/sewer/stormwater/pipelines etc, it is the responsibility of the Contractor to carry out such work without affecting water supply/without affecting sewage disposal etc. If required alternative temporary arrangement shall have to be made by the Contractor.
18. In case of temporary water pipe/sewer pumping mains (without manholes) etc. diversion (which means divert the pipeline temporary away from station box and brought back to the original position after completion of station work), it is the responsibility of the Contractor either to use the retrieved diverted pipes or new pipes to restore back the original place without affecting the water supply/utility service.
19. In case of temporary diversion of gravity sewer pipelines with manholes are required, the Contractor, initially before taking up the station work has to ensure that the flow is diverted by laying sewer pipeline and constructing manholes away from the station box and then only divert the flow. After completion of station work, the Contractor shall have to lay again another sewer pipelines and again construct new manholes for restoring back to the original place.
20. In case of temporary supporting of water/sewer pipelines, if any damages occur during construction period it is the responsibility of the Contractor to rectify the damages to the satisfaction of PMC /relevant agency Engineers. The cost of the rectification works shall have to be borne by the Contractor.
21. It is the responsibility of the Contractor to obtain completion certificate from PMC / concerned agency WSS for each diversion work. The payment for such work will be made to the Contractor after obtaining completion certificate from PMC /concerned agency.
22. **Maharashtra State Electricity Board (MSEB)** The Contractor shall be responsible for diversion of utilities with respect to the MSEB (Electrical utilities) works. The Contractor shall carryout the diversion works complying with the following conditions.
23. The Contractor shall submit the utility diversion programme to PMRP/the Engineer with

diversion justification based on trial pit information.

24. The Contractor shall submit the diversion plan to Engineer at least 60 (sixty) days in advance of work commencing to obtain approval from MSEB/MSEB. For utility diversion proposals of MSEB, the Contractor shall submit diversion justification with trial pit information and drawing(s) with the proposed diversion route(s).
25. The Contractor would submit application of diversion works to MSEB with diversion plans. The Contractor shall render necessary assistance.
26. The Contractor shall coordinate with the MSEB' local officials to assess quantities and specifications of materials required for diversion works. Necessary assistance would be provided by the Employer and the Engineer.
27. The Contractor shall obtain necessary permission from the MSEB to carry out the diversion/shifting works and get necessary permission from Traffic Police Department.
28. Wherever possible, trenchless technology shall be adopted at location where utility diversion works crosses roadways and require lane closures for excavation to avoid inconvenience to the traffic.
29. The electrical utilities diversion/ shifting should be carried out by the Contractors/agencies registered with the MSEB / PPWD and have the required grade license from the Chief Electrical Inspector to Government. The Contractor should be well acquainted with electrical works so as to maintain the concerned MSEB' standard. The Contractor shall inform the same to PMC/the Engineer for getting consent from the concerned electrical utility agency
30. The Contractor shall identify the quantity of materials required for the contract such that the material can be procured by the Contractor in bulk and in advance to the implementation of the utility diversion works. The quality of materials to be procured shall be approved by the concerned utility agency. Materials used for diversion / shifting shall be of quality conforming to the applicable standard of the electrical utility agency and as per relevant BIS.
31. The source of materials and the guarantee for the materials to be used shall be submitted to Engineer for obtaining approval from the concerned utility agency . Any failure of the material within the guarantee period shall be replaced and installed free of cost by the Contractor.
32. Contractor shall inform the local officers/officials of the concerned utility agency about the diversion works at least 15 (fifteen) days before the execution of diversion.
33. The diversion / shifting utility work shall be carried out under the direct supervision of electrical utility agency's officials and the utility agency's decision shall be final in this regard.
34. The Contractor shall provide free access to utility agency's officers/ officials / workman for the purpose of inspection / supervision..
35. After restoration of regular service completion certificate shall have to be obtained from the MSEB. The regulations for working with utility agencies shall be as follows;
 - a. The diversion/shifting utility work should be carried out without causing any inconvenience to the operation and maintenance of Sub-Station and other departmental works of the MSEB.
 - b. The Contractor shall execute and complete the work strictly in adherence to the time schedule and to the satisfaction of the concerned utility agency's engineers and adhere strictly the direction from in any matter.

- c. The Contractor shall be responsible to protect the public and the employees of the MSEB against any accident that may arise during the execution of diversion/shifting utility works. The Contractor shall indemnify the PMC/MSCB for any claims for damages/injuries to the person/property resulting from any such accident. The Contractor shall take steps to properly insure against claims under the Workmen's Compensation Act by the way of obtaining an accident risk type insurance to meet all purpose of relief, failing which or otherwise the Contractor shall be solely responsible for meeting the compensation awarded under the said Act.
- d. The Contractor shall undertake to ensure free flow of traffic during execution of the diversion/shifting works and shall be responsible for any accident/loss of lives/property. Damage to the other existing utilities during diversion shall have to be rectified by the Contractor free of cost.
- e. The Contractor shall employ qualified technical personnel to carry out the diversion/shifting of utility works.
- f. The Contractor shall apply well in advance for Line Clearance (LC) for carrying out the joint works/shifting works. PMRP would authorise the Contractor to take LC from the MSEB. If needed, PMC would provide assistance to the Contractor to get the LC. LC will be given by the MSEB depending upon exigencies, which have to be strictly adhered to.
- g. The Contractor shall handover all the retrieved / unused material to the stores of the concerned utility agency /concerned department at the Contractor's cost.
- h. The Contractor shall undertake not to revoke the above conditions until the completion of diversion/shifting works.

Pune Municipal Corporation (PMC) / concerned Highways Department

- 35. Diversion of Storm water drain shall be carried out as per the design, standard and general specifications of PMC / concerned Highways Department.
- 36. The diversion route for storm water drain shall be approved by PMC/ concerned Highways Department.
- 37. The invert level of diverting drain shall be maintained on par with upstream/downstream of connecting drains.
- 38. The Contractor shall make alternate arrangements to divert and ensure smooth flow of water from upstream side during construction.
- 39. The Contractor shall provide the adequate sizes of drain or follow the existing sizes as agreed by the concerned agency.
- 40. Diversion of storm water drain shall be carried out through the registered Contractors of PMC/ Highways Department (if such a list of approved/registered contractors is maintained by the utility agency).
- 41. The Contractor shall obtain No objection certificate from PMC/ concerned Highways Department upon completion of diversion works.
- 42. The Contractor shall make necessary preventive measures to avoid damages to the adjoining building and compound wall.

General

The Contractor shall provide a 6 months rolling programme every 3 months.

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Tender Documents

**UGC-01: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 13 – Site Accommodation For The Engineer

June 2018

ACCOMMODATION FOR THE ENGINEER

- Accommodation for the Engineer / Employer shall consist of a Principal Office and 2 Number of site offices to be located at the Contractor's principal Works Areas.

The principal site office shall be close to the Contractors main office and allow for the following rooms

PRINCIPAL SITE OFFICE	No of Staff	Area (Sq. m)	Area required (Sq.m)
Project Manager	1	20	20
Chief Resident Engineer	1	15	15
Resident Engineers (Tunnel/Stns)	2	15	30
Utility & Traffic Engineer	1	12	12
Survey Expert	1	12	12
Safety & Environment Engineer	1	12	12
QA/QC Engineer	1	12	12
Quantity surveyor	1	12	12
Section Engineer(Tunnel)	2	7.5	15
Section Engineer(stns)	2	7.5	15
Site Engineer (Tunnel)	2	5	10
Site Engineer (Stns)	6	5	30
Office Manager	1	10	10
CAD Operator	1	8	8
Secretary	1	8	8
Meeting Room (Large)	1	25	25
Meeting Room (Small)	1	10	10
File & Document Storage	2	15	30
Toilets with Changing Room	2	15	20
Pantry	1	10	10
Employer's Office	2	15	30
Entrance / Corridor		10	10
TOTAL			360 Sq.m

The 2 site offices shall be each 125sq meters of useable office area to be located as agreed by the Engineer.

Offices shall be accessible only from a corridor within the building. An external double door with reception area shall be provided to the corridor.

2. Materials used for the construction of the offices shall be new and of good quality. Materials shall be chosen such that the buildings when erected shall give good heat and sound insulation, and when combined with the heating and air condition equipment installed by the Contractor will enable interior temperatures to be maintained at within a range of 20-24 deg. C. at all times. (with Approx. 30% area as air conditioned) Both external and internal walls shall be sound proof.
3. Windows to each room shall be of an area not less than 10% of the floor area. All windows to ground floor offices shall be fitted with burglar bars firmly attached to the structure of the building. All windows shall be fitted with mosquito netting. All opening windows shall be fitted with locks and all sets of keys shall be delivered to the Engineer. All windows shall be fitted with Venetian blinds.
4. Internal doors shall be hollow core flush doors and shall be fitted with door closers, lever latches, mortise lock and keys.
5. External doors shall have barrel bolts both at top and bottom of one leaf and a Yale lock on the other leaf. External doors shall be of solid external quality and hung with heavy-duty hinges.
6. All buildings shall be supplied with continuous (24 hour) running potable cold water to the kitchens and wash rooms. The toilets may use raw water for flushing, shall be equipped with water closets and sitting type stools and shall be adequately ventilated through the ceiling. The Contractor shall also arrange for the constant and hygienic disposal of all effluent, sewage and rubbish from the buildings. Storage tanks will be required due to restricted hours of water supply in the Bangalore Area.
7. All buildings shall be supplied with electricity at 240 voltage and 50 Hz that shall be distributed to each room in accordance with the Regulations. Lighting and electrical power points shall be provided in each room. The disposition and location of light and power points will be as directed by the Engineer. A back up generator is required to be provided to meet the full power load in case of power disruption.
8. Each kitchen shall be provided with worktops, a 2 drainer stainless steel double sink, cupboards beneath the worktop and mounted on the walls, a cooker with 2 no. 2 gas rings and a microwave oven and a 5 cu ft. refrigerator. Coffee making facilities for 20 persons shall be provided. Tiling shall be provided to the walls above the sink, cooker and worktops.
9. Changing and shower facilities shall be provided as follows:
 - Male facilities: 2 showers and 2 wash basins with 10 clothes lockers and benching with pegs over for 6 persons.

- Female facilities: 1 showers and 1 wash basins with 5 clothes lockers and benching with pegs over for 4 persons.

Each shower shall be provided with hot and cold water supply and shall be contained in an individual cubicle with a screen or curtain to the entrance. Modesty screens shall be provided adjacent to the entrance to all changing and shower facilities.

10. Fire fighting equipment shall be provided in accordance with the recommendations of the Maharashtra Fire & Emergency Services.
11. The Contractor shall provide, erect and maintain appropriate name boards as specified for each of the offices. The wording on each name board and its location shall be agreed by the Engineer before it is erected.
12. Where Tunnelling machines are used the Contractor shall provide monitors and data inputs to the Engineers offices to allow real time representation of the key TBM parameters and viewing access to any CCTV cameras installed in the tunnels.
13. All site office shall have internet facility
14. Principal site office shall have video conferencing facility
15. The Contractor shall supply the following new furniture and equipment to the Engineer's offices in the manner required by the Engineer :

- Conference table (2400 x 900) 3 No
- Conference chairs 30 No

All other Facilities as shown in Annexure 1

- Communication Facility

All other Facilities as shown in Annexure 1

Other office stationary

- Waste paper baskets 20 No
- 4-hole document punches 2 No
- Desk mounted pencil sharpeners 20 No
- Desk tray sets 50 No
- Plan meter set 2 No
- Fully automatic camera with date and time 2 No
- Recording facility downloadable to a PC 1 No
- First aid kits for up to 36 persons 4 No
- Safety helmets 90 No
- Safety harness 20 No
- Pairs steel toed construction boots 60 No

-	Sizes to be advised	90 pr.
-	Day-Glo waistcoat	60 No
-	Pairs steel handling gloves	12 pr.
-	Pairs industrial safety goggles	12 pr.
-	Breathing masks and filters	12 No
-	5 L kettles	2 No
-	2 L kettles	4 No
-	Heavy duty cotton trousers and 'T' shirts with collars and breast pockets (long and short sleeved) and the Laundering thereof	120 No
-	Potable water dispenser with hot/cold taps and paper/plastic cups	6 No
-	Hot water heaters for kitchen and showers	9 No
-	cups and saucers	60 No
-	Side plates	60 No
-	15-piece dinner service	1 set
-	15-piece cutlery service	1 set
-	Fire extinguisher	10 No
16.	The Contractor shall supply the following personnel as required	
	Chainmen / Staff men	9 No
	Field / Office Attendants	8 No
	Messengers	8 No
	Watchmen	6 No
17.	The Contractor shall provide Following to NMRCL or its designated Engineer for proper Management & supervision of construction work :-	
	Civil Team : Four number of AC SUV i.e. Innova/Xylo/Ertiga etc.. with driver for 24 hours. Maximum running of each vehicle shall be 4000 Km/month. The maintenance expenses, wages of drivers, insurance, POL, toll, parking and other running expenses of these vehicles shall be borne by Contractor. Make of all the car to be provided for Employer shall not be earlier than 2016.	
	MEP Team : Two number of AC SUV i.e. Innova/Xylo/Ertiga etc.. with driver for 24 hours. Maximum running of each vehicle shall be 4000 Km/month. The maintenance	

expenses, wages of drivers, insurance, POL, toll, parking and other running expenses of these vehicles shall be borne by Contractor. Make of all the car to be provided for Employer shall not be earlier than 2016

18. In principle site office, space for the following should also be provided apart from existing requirement:

1 no. for GM (Underground),
2 numbers for E&M Experts (of Engineer),
2 numbers for E&M Engineers (of Engineer),

Out of 2 site offices, one 125 sqm of site office with fully equipped facilities should be dedicated for E&M team.

The Printer's cartridges and printing papers of A4, A3, A2, A1 and A0 sizes, whichever is applicable and in required quantities during execution of work, for this project only, apart from the other consumables etc. as mentioned in the tender should be provided for total contract period of 180 weeks.

Annexure 1

PRINCIPAL SITE OFFICE	No. of Staff	Sr. Ex. Table	Ex. Table	Manager Table	Sr. Chair	Ex. Chair	Manager Chair	Sofa	Visitor Chair	laptop	Desktop	Printer	BSNL Land Line Phone	Mobile	Digital Camera	PBAX	Vehicle	Cad Operator	Secretary	Side Unit with Sliding D	Filing Cabinets	Chairman	Messenger	Attendant	Security (24 hrs)	Conference Table	Plotter	Refrigerator	Microwave oven	Drawing Cabinet	Tea/Coffee Dispenser	Water cooler/ Dispenser	Xerox Machine	Fire Extinguisher	Hot case	Steel Door Cupboards	Scanner	Fax		
Project Manager	1	1			1			1	4	1		1	1	1		1			1	1	1			1																
Chief Resident Engineer	1	1			1			1	4	1		1	1	1		1		1	1	1	1			1																
Resident Engineer (Tunnel/Stns)	2	2				2			4	2			2	2	2	2			2	2	2			1																
Utility & Traffic Engineer	1		1			1			2		1			1		1																								
Survey Expert	1		1			1			2		1			1		1																								
Safety & Environment Engineer	1		1			1			2		1		1	1		1																								
QA/QC Engineer	1		1			1			2		1			1	1	1																								
Quantity survey0r	1		1			1					1		1	1		1																								
Section Engineer(Tunnel)	2		2			2			4		1		1	2		2																								
Section Engineer(stns)	4		2	2		2	2		2		2		1	4		1																								
Site Engineer (Tunnel)	2			2			2				1			2		2																								
Site Engineer(Stns)	6			6			6				3			6		6																								
Office Manager	1			1			1		2		1		3	1		1																								
TOTAL INDIVIDUAL FACILITIES		4	9	11	1	11	11	1	24	3	13	1	11	24	3	21		1	4	4	4			3																
	Common Facilities																																							
Office			4	6		4	6		12		2	2									4	3	5	3	2	1	1	1	1	4	1	2	1	1	2	1				
Main office														7				2	2	2	4	4	8																	
Client		1	2	1	1	2	1	1	8	1	3	4		3							1	1	2							1					1	1	1			
TOTAL COMMON FACILITIES		1	6	7	1	6	7	1	20	1	5	6		10				2	2	2	5	9	13	5	3	2	1	1	1	1	5	1	2	1	2	3	2	0		
GRAND TOTAL		5	15	18	2	17	18	2	44	4	18	7	11	34	3	21		3	6	6	9	16	13	8	3	2	1	1	1	1	5	1	2	1	2	3	2	0		

Maha Metro



Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 14 – Contractor’s Site Laboratory

June 2018

CONTRACTOR’S SITE LABORATORY

Maha-Metro in collaboration with Bureau Veritas (An international NABL accredited third party lab/organization) will be setting up “material testing lab” at Pune with facilities and procedures as per the international standards. All third party testing, validation, safety cum quality audit (as per the need and direction of Maha-Metro) for this Package shall be carried out in this lab and the cost of the testing shall be borne by the Contractor. The said lab may also take up day to day testing of all civil and system works if the contractor desires so apart from witnessing calibration of various equipment and ‘onsite’ testing of ingredients involved in concreting. These testing shall be carried out at nominal rate.

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Maha Metro



Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 15 – Design Consolidated Unit Requirements

June 2018

DESIGN CONSOLIDATION UNIT REQUIREMENT

15.1 Purpose of Requirement

This Employer's requirement aims at:

- defining the scope of the Design Consolidation Unit,
- describing how the submission of the Consolidated Design drawings to the Engineer shall be performed, and
- providing an outline for the overall design consolidation process as to design, verification and notice activities.

15.2 Scope.

This Employer's Requirement covers all deliverables documents prepared by the Contractor throughout Design and Construction stages.

The Design Consolidation Unit shall be part of the Contractor's organization with its main purpose to be to provide a final control over technical drawings.

This Design Consolidation shall be managed by a Design Consolidation Manager, in charge of :

- Managing and coordinating activities of all parties involved in the design and Design Consolidation process,
- Scheduling and managing dedicated technical design and consolidation meetings,
- Identifying complex technical and geometrical conflicts,
- Checking and approving technical Design Consolidation deliverables,

He is assisted by Consolidation Draftsman(s), in charge of :

- Creating the Consolidated Design drawings by compiling Xrefs ACAD files,
- Identifying technical and geometrical conflicts,
- Preparing & issuing Minutes of Technical Design and Consolidation Meetings,
- Updating the files with due diligence and storing them,

The Design Consolidation activity shall be performed with 1:200 scale drawings.

15.3 Process

Draft Design Consolidation drawings (soft & hard copy) shall be submitted to the Engineer for notice as per the Contractor's design schedule and as required by attachment A1 of Section A of this Section VI, Part 2

15.4 Consolidated Design Drawings Contents.

Consolidated Design Drawings (scale 1:200) are composed of a compilation of several "x-refs" files. Working files are registered as per a commonly agreed WBS.

The following shall mandatorily be taken into account:

- Topography
- Furniture
- Land use
- Dry Utilities
- Wet Utilities
- Trackway Alignment
- Cable ducts & trays (Low Voltage, Traction Power, Water, Air etc.)

- Planimetry
- Structures
- Catenary

For clarity's sake, layers including texts, comments, and levelling points shall be frozen.

The Consolidated Design drawings shall include the Combined Services Drawings and Structural Electrical and Mechanical drawings.

15.5 Work Schedule.

The Design Consolidation Unit shall comply with deadlines set by the Engineer for submitting deliverables. Each party being involved in the Consolidation process shall be fully responsible for its own lead-times in order for delays accumulation to be avoided.

The usual time schedule is as follows (calendar days):

When?	Who ?	What ?
Submission Date = J	Design Consolidation Manager	Approval & Submission to the Engineer <u>version A02 or A03 where modifications have been made.</u>
J	Design Consolidation Manager	Verification and issuance to the Engineer.
J - 1	Design Consolidation Draftsman	revision <u>version - 02</u> Second Consolidated Design drawings compilation, additional issuance of.pdf & .plt files Last x.refs update
J - 3	Draughtsmen	x.refs modifications
J - 9	Design Consolidation Draftsman	Preparation & issuance of Design Consolidation Minutes of Meeting, and « Comments file »
J - 10	Design Consolidation Unit	Design Consolidation Meeting
J - 11	Design Consolidation Draftsman	Consolidated Design drawings <u>version- 01</u> , editing of A0 & A4 drawings, identification of geometric & technical conflicts
J - 12	Draughtsmen	Preparation of x.ref files
J – as per approved schedule	Design Consolidation Manager	Choice of section for Design Consolidation activity

15.6 Design Consolidation Unit Flow Chart

The different steps of the Synthesis process are listed hereafter:

Parties		Steps	Documentation
Contractor Draughtsmen	1-	File Storage	● x.ref AutoCAD as per list (section 3.2, Appendix -7)
Design Consolidation Draftsman	2-	Consolidated Design drawings preparation	● File version 01 Associated AutoCAD file
Design Consolidation Draftsman	3-	x.refs compilation	● Related Documentation (x.ref)
Design Consolidation Manager	4-	Technical & geometric conflicts identification	● Synthesis drawings (A0 & A4 sizes)
Design Consolidation Manager and Draftsman	5-	Design Consolidation Meeting	● Minute of Meeting + comments file
Contractor Draughtsmen	6-	x.ref modifications Conflicts analysis	● Related Documentation (x.ref) version n+1
Design Consolidation Draftsman	7-	Reference files update	● Idem step 3 (x.ref n+1) & synthesis drawings version 02
Design Manager	8-	Verification & Approval	● visa transmittal sheet
Project Manager	9-	Approval & issuance to the Engineer.	● Synthesis drawings dwg-pdf-plt Hard copies A0+A4 Transmittal sheet version A03

15.7 Process Detailed Description.

Step 1

Working ribbon files including all relevant technical disciplines (x.refs) shall be stored by draughtsmen within a dedicated Electronic Content Management system. The format of these files shall be compliant with agreed CAD Management procedures.

Step 2

Preparation of Consolidated Design drawing: files compilation in accordance with the Content of Technical Synthesis Drawing list.

Step 3

When all files are assembled for one specific section, hard A0 & A4 copies shall be printed out, bearing the « **version 01** » mark, to identify conflicts.

Step 4

Design Consolidation Meeting, called for by the Design Consolidation Manager, in order to check the following :

- Consistency,
- Modifications to be brought towards identified conflicts
- Submission Deadline definition

Step 5

Modifications of working ribbon files (x.refs) by draughtsmen, according to the Minutes of Design Consolidation Meeting.

Step 6

Update of Consolidated Design drawings with latest versions of reference files.
hard A0 & A4 copies shall be printed out, bearing the « **version 02** » mark, to identify conflicts.

Step 7

Design Consolidation Meeting, called for by the Design Consolidation Manager, in order to check **version 02**.

Step 8

Design Consolidation Approval by Project Manager

Step 9

Printing of **version 03** per section, for submission to the Engineer.

Maha Metro



Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 16 – Earthing and Grid

June 2018

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1. INTRODUCTION

1.1 Scope

- 1.1.1 The purpose of this Earthing, Bonding, Lightning Protection and Corrosion Protection Policy is to define the requirements for the earthing and bonding of the electrical power supply systems and other parts of the Metro system to ensure, as far as possible:
- i) the safety of operating personnel and other persons from electrical shock.
 - ii) the minimum of electrical interference between the electrical power supply and other electrical and electronic systems and the protection of electrical equipment.
 - iii) the minimum of disturbance to existing statutory services and parts of the Metro system due to any electrolytic corrosion effects arising from AC traction currents flowing to and from the general mass of earth.
- 1.1.2 This document is divided into several sections. Sections 2 and 3 are of a general nature whilst Sections 4 to 7 deal with specific items under system and equipment- specific general headings and Section 8 deals with stray current corrosion control
- 1.1.3 It should be noted that no Single section can be taken alone as being complete in itself in covering all aspects of earthing under the general heading of that section. In the implementation of the earthing policy account has to be taken of the interrelationship, interface and integration of all systems comprising the Metro system.
- 1.1.4 The Contractor shall develop his own designs as required for Earthing, Bonding, Lightning Protection and Stray Current Corrosion Control, using this document as a basis for doing so, which shall require a notice of no objection from the Engineer , prior to commencing any such works.
- 1.1.5 The Contractor shall coordinate his designs for Earthing, Bonding, Lightning Protection and Stray Current Corrosion Control as required with all Interfacing Contractors.
- 1.1.6 Reference in other documents to "Grounding" shall be taken to be synonymous with 'Earthing'.

2. CATEGORIES OF EARTHING

2.1 General Requirement

- 2.1.1 The earthing system shall be capable of carrying full fault currents. The earthing system provided at any location may be common to two or more categories of earthing, in which case all the earthing points on the individual items of equipment will be bonded together to discharge any earth fault currents: In general, earthing and bonding is required under one or more of the following categories.

2.2 Neutral Earthing

- 2.2.1 Connection to earth at one or more nominally equipotential points of the current-carrying conductors of each section of the power supply system shall be arranged to ensure that the voltage at any point in the system relative to the general mass

of earth will be within defined limits and will provide a low impedance path for earth fault return currents.

- 2.2.2 For low impedance earth paths to be established the ground conditions must first be measured (earth/ground resistivity Ohms / m) and the system designed according to the results. Allowance shall be made for the fact that conditions may vary throughout the year due to seasonal weather.

2.3 Protective Earthing

- 2.3.1 Connection to earth at one or more points of the non-current-carrying parts of electrical equipment shall be arranged to ensure that, in the event of a failure of insulation or other inadvertent connection between current and non-current-carrying

parts, no dangerous potential difference occurs between the non-current-carrying parts of the equipment and the general mass of earth or adjacent equipment, and to provide a low impedance path for earth fault currents.

2.4 Adjacent Metallic Structures

- 2.4.1 This relates to connection to earth of metallic structures, which are not part of the electrical equipment but are in close proximity to the electrical system.

2.5 Mitigation of Interference Effects

- 2.5.1 This relates to the connection to earth of the screening of light current signal and control cables. The connection to earth of the screening conductors of any light current cables will, in general, be confined to one end in order to avoid circulating currents in the screen causing interference on the signal cores.
- 2.5.2 There may be exceptions to this and EMC considerations will determine the solution to be adopted in individual cases.

2.6 Treatment of unearthed systems

- 2.6.1 This relates to unearthed systems where the current carrying conductors are fully insulated from earth at all points. No part of such a system need to be automatically disconnected immediately on the occurrence of a single earth fault in that part. However special care needs to be taken during design and installation when considering this type of earth system.

2.7 Earthing for Lightning Protection

- 2.7.1 This relates to the protection of buildings and structures from lightning by the provision of lightning arrester and hence connection to the earth electrode system. Account shall be taken of the locality and lightning incidence rate and applied to the protection of the Railway Systems as a whole from "Far" and "Near" strikes, individual structures and personnel protection.

2.8 Traction return current circuit

- 2.8.1 This relates to the connection to earth of the track rails and the protection cables (Buried Earth Cable, Aerial Earth Conductor, etc).

3. GENERAL REQUIREMENTS

3.1 Legislation and Standards

- 3.1.1 Earthing, bonding, lightning and corrosion protection has to be in accordance with applicable requirements related to the Metro systems, for the purposes of this, the Earthing Policy on the Project shall be assumed to be no less onerous than the relevant requirements of the following standards
- a) European Standard EN50122-1 - 'Railway Applications Fixed Installations Protective provisions relating to electrical safety and earthing'.
 - b) European Standard EN50122-2 - 'Railway Applications - Protective provisions against the effects of stray currents traction systems
 - c) British Standard 7361, Part 1 - Cathodic Protection - Code of Practice for Land and Marine Applications.
 - d) International Union of Railways Codes (UIC) 605 'Protection from Corrosion' - Measures to be taken on catenaries to reduce the risk on adjacent piping and cable systems.
 - e) BS 7671 - Requirements for Electrical Installations
 - f) IEC 60364 - Electrical Installations of Buildings
 - g) IEC 61312 - Protection Against Lightning
 - h) IEC 61024-1; Protection of Structures against Lightning, Part 1: General Principles.
 - i) IEC 61024-4; Series protection against lightning electromagnetic impulses for structure with electrical and electronic systems.
 - j) IEC 61000-5 Edition1, Electromagnetic Compatibility (EMC) Part 5
 - k) BS 7430 - Code of Practice for Earthing.
 - l) ANSI/IEEE 80 - Earthing of Substations
 - m) IS—3043--EARTHING & IS: 2309 - LIGHTNING PROTECTION
 - n) BS-1013---SUBSTATION EARTHING
 - o) NFPA-- 780-- LIGHTNING PROTECTION
 - p) IEEE- 1100—EARTHING OF ELECTRONIC EQUIPMENT EN- 50122-2 Insulation from Earth
 - q) EARTH RESISTANCE VALUES (ETI/PSI/EARTHING OF RDSO) RDSO's Code No: ET1/PS I /120 (2/91) Code of practice for earthing of Power Supply Installation for 25kV ac single phase traction system
 - r) European Standard EN50121-1 -Railway Applications – Electromagnetic compatibility - General'.
 - s) European Standard EN50121-4 - Railway Applications – Electromagnetic compatibility – Emission and immunity of the signalling and telecommunications apparatus'.
 - t) European Standard EN50121-5 - Railway Applications – Electromagnetic compatibility – Emission and immunity of fixed power supply installations and apparatus'.
 - u) RDSO/SPN/144/2004 Safety and reliability requirement of electronic signalling equipment,
 - v) Local Codes. These may however conflict with International Codes/Standards in which case discussion and agreement with the Engineer will be required.

3.2 Treatment of AC Power Supplies

- 3.2.1 The general policy followed in this document is to provide an earth farm/Mats for each of the auxiliary substations and at other locations as required for purposes of earthing AC power supply systems under the category of Clause 2.2 and metallic enclosures and structures under Clauses 2.3 and 2.4.
- 3.2.2 The earth farms at each substation and other locations shall be multiple-interconnected by provision of bonding connections cable sheaths, cable armouring, to adjacent earth farms to form an incidental earth mat embracing the whole of the Metro system
- 3.2.3 The armouring of HV power supply cables will not be connected to the incoming supply to the bulk substation earthing system (this must be agreed with the local authority) or other mitigation measures taken. However, there shall be provision to do so conveniently on a temporary basis whilst work and testing requiring this is carried out.
- 3.2.4 The alternative solution of segregating the utility supplier and Metro system earth farm and its associated earth system from utility supplier earth farms and earth systems could be difficult to implement and to maintain.
- 3.2.5 Although segregation will tend to discourage the flow of stray traction currents through the earth systems, this will not necessarily decrease the corrosion of particular electrodes and may well encourage stray currents to pass from buried structure to buried structure, leading to corrosion of the structures.
- 3.2.6 Two other difficulties that could arise with segregation are as follows:
- a) transferred potentials will appear across insulated joints used to segregate the systems where there are interconnecting cables etc. and between adjacent structures bonded to different earthing systems
 - b) provision of earthing for the screening of telecommunications cables to reduce interference (Clause 2.5 above).
- 3.2.7 For the reasons described above, the effects of the segregation will need to be monitored closely.

3.3 Treatment of Unearthed Auxiliary Supplies

- 3.3.1 Certain low voltage auxiliary, signalling, control or indication systems come under the category of Clause 2.6, where the ability to temporarily continue in operation with a single earth fault gives increased security of supply. The signalling or control circuit can be isolated from Earth to avoid mal-operation or Nuisance. Tripping of the control circuit which will therefore need its own Alarm to draw attention to this fact and hence start the fault rectification process (normally by manual investigation and maintenance operations).
- 3.3.2 The incoming power supplies to the control system however may have their own Earth Fault detection.

3.4 Lightning Protection

- 3.4.1 The protection of above ground structures from lightning under the category of Clause 2.7 is included within this policy document.

3.5 Traction return current circuit System

- 3.5.1 The Power Supply and Traction contractor will have to handle a traction power supply simulation. The traction return current circuit will be designed according to tender requirements, standards and traction simulation results.

4. OVERALL EARTHING STRATEGY FOR THE PUNE METRO PROJECT

4.1 Earthing, Bonding, Lightning Protection and Corrosion Protection Principles

- 4.1.1 Taking into account the previous general requirements in section 3:
- a) A "Structure Earthing" strategy shall be applied throughout the Pune Metro Project to ensure electrical safety and provide the basis of lightning protection;
 - b) All trackwork with workshop buildings shall be bonded to the structure earth of the building.
- 4.1.2 All buildings / structures shall be connected to mass earth via earth farms/Mats which form part of the building / structure foundations and this earth shall be continuous through all building structures by the appropriate interconnection and bonding of all metalwork.

4.2 Tunnels

- 4.2.1 The reinforcement of the cut and cover tunnel frame forms the earthing system of tunnel sections. On top of the tunnel segment, a track sub-structure (e.g. slab or plinth) will be installed and fixed by means of connecting reinforcement. The reinforcement of the tunnel forms the structure earth of tunnel sections. In each section some dedicated longitudinal reinforcing rods of the uppermost reinforcement layer shall be used for earthing. These dedicated rods shall be cross bonded appropriately at the beginning and at the end of the segment. The cross bonds are made accessible for connection of the segments to each other. From this grid of longitudinal rods and cross bonds, connections will be provided to items on the tunnel to be earthed. The longitudinal rods must be cross bonded at each construction gap at minimum. For bored tunnels, the precast concrete segments, are individually reinforced but are not interconnected. Due to the watertight membrane separating the inner from the outer shell, the bored tunnel structure is not regarded to be effective for earthing purposes. Because of the small distances between reinforcement of individual segments, the inner tunnel shell is regarded to be potentially conducive for higher voltages. Therefore protective provisions against unintended transfer of dangerous potential shall be required. In these tunnel sections a protective wire shall be used within the pantograph zone and all rigid bar supports shall be connected to the earthing system. Apart from that for earthing purposes all conductive structures within the tunnel shall be bonded to the earthing system, especially continuous conductive structures shall be connected in regular distances, not exceeding 250m in any case.

4.3 Stations

- 4.3.1 Station buildings shall be provided with a structure earth. Earthing terminals shall

be necessary for LV power supply rooms, Technical rooms and facilities like Lifts & Escalator and for steelwork like the roof supports etc.. The roof constructions of the above ground parts of underground stations (entrances, Ventilation shafts and ancillary buildings/structures etc.) shall be provided with an external lightning protection system. The lightning protection system must be connected to the structure earth to avoid dangerous voltage differences. Equipotential bonding shall be provided to avoid safety issues. The trackside earthing and bonding measures are the same as for the tunnels. That means all structure parts of station buildings, which are located within the OCL/RCS and pantograph zone have to be earthed similar to other structures. Continuous electrically conducting bars of adequate cross-sectional area ($2 \times 200 \text{ mm}^2$) have to be embedded parallel to the track as described below at all reinforced concrete structures. The conducting bars have to be positioned as follows:

- Above each overhead line (only in covered area)
- In walls within the OCL zone
- In floors adjacent to the tracks within the OCL zone

4.3.2 The Earth mat (to be provided by the Civil Contractor) design shall ensure that the potential rise is limited to 4.0V above water earth. Disturbances from HV, LV, traction supplies when supporting the most adverse traffic pattern and PG (power generating) sources shall be considered. The Earth mat should be designed to limit the coupling from any lightning system earth mat to 110V when a discharge of 100KA lightning stroke occurs. The ohmic value of main earthmat shall not be more than 1 Ohm and for clean earthmat it will not be more than 0.5 ohms..

4.3.3 The Ringed earth mat shall comprise of earth rods inclusive of electrode pits and heavy duty cover and 95 sq.mm bare stranded copper wire laid 300mm below basement slab/ground level. The earth rod is made up of two lengths of 1.8m, 16mm diameter copper bond steel rods coupled together with silicon aluminium bronze coupling and copper wire joints are by exothermic weld and must be inspected before backfilling. One earth riser cable 185 sq mm XLPE shall be brought from the earth mat up through the basement floor or wall to each of the substation rooms, communication Equipment room, SER, SCR and other equipment rooms to the Engineer's acceptance. At each earth riser cable entry through the base slab, a tinned copper waterstop sleeve shall be provided to prevent the ingress of water. The sleeve shall be coated with epoxy resin.

4.3.4 Further flat earth bars earthing terminals shall be provided in:

- a) Every Station Control Room
- b) Every Ticket Office
- c) Every plant and equipment room
- d) Other locations where required as an earthing point for metal work and lightning protection. (It should be noted that general earthing of typical electrical equipment should be through the reticulated earth of the low voltage power supply system or back to the nearest earthing terminal.)

4.3.5 The flat steel bars shall be provided by the Civil Contractor to a design provided by the power supply contractor.

- 4.3.6 Any distribution of earthing required beyond the above nominated locations shall be provided by the respective contractors responsible for the provision of the particular equipment.
- 4.3.7 Lightning interception facilities shall be provided on the roofs of buildings I structures which shall be securely bonded to the structure earth of the building I structure. These (Structure earth) shall be provided by the Civil Contractor to a design provided by the power supply contractor.

4.4 Main Line and Depot External Track work

- 4.4.1 In order to ensure electrical safety and prevent the potential of the running rails rising to excessive potentials above the structure earth, proper earthing shall be used at appropriate locations to clamp the running rails to the structure earth. These shall be provided by the power supply contractor at an appropriate number of locations to control the rail potential to safe levels. As a minimum, one shall be provided at each station and in each depot external area
- 4.4.2 The Main Line track work and the depot external track work shall be electrically isolated from each other by the use of insulation joints boundary

4.5 Depot Workshop Track work

- 4.5.1 The running rails and traction return system of the Pune Metro Project within the depot workshops shall be solidly bonded to the traction return earth. If a depot building has an OCL, then the measures as described for passenger stations shall be applied. All individual earthing installations and conductive parts of the depot and workshop area shall be equipotential bonded. The totality of all earthing installations connected to the equipotential bonding conductor forms the structure earth of the depot and workshop area. Additionally for all major workshop equipment, like under floor wheel lathe, wheel press and all other maintenance equipments earth terminals for direct earthing at structure earth, shall be provided.
- 4.5.2 The traction return rails for the depot workshop and the pit wheel lathe lane are electrically isolated from the main line by means of insulated rail joints.

4.6 Traction return current circuit

- 4.6.1 The traction return current circuit of the Pune Metro Project will use the rail and the following return current conductors:
- Buried Earth Cables
 - Aerial Earth Cables
 - Integral Transverse Bonds.

Cables cross sections will have to conform to EN 50122. Buried Earth cable, Aerial earth cable, Integral Transverse Bond and Earth pit when available, will be bonded together:

- on earth bar provided at the bottom of OHE mast on ramp/viaducts and in Depot
- on earth connecting box in stations and in underground.

4.7 Interfaces

- 4.7.1 The design basis/philosophy of the earthing, bonding, lightning protection and corrosion protection of the Pune Metro Line-3 Project shall be developed by the Power Supply and Traction contractor. The design basis of the overall Traction (RSS/TSS) and Auxiliary (ASS) sub-stations' earthing & bonding, and corrosion protection of the Pune Metro Project shall be undertaken by the Power Supply and Traction contractor. According to the so provided design, the Civil Contractor will install the earth mat and bring up the stubs at platform level or at 300 mm level in tunnels or as required. Then the Civil Contractor (as part of his MEP/E&M scope of works) shall ensure a double loop earthing system and integrate with the traction earth system provided by PST Contractor.
- 4.7.2 During the development of its design, the Power Supply and Traction contractor shall coordinate/include the earthing requirements of all Interfacing Contractors.

5. EARTHING OF POWER SUPPLY SYSTEMS

5.1 Supplies

- 5.1.1 The electrical power supply systems comprise 100/33 kV (or as finalized by the Power Supply and Traction contractor during detail design stage), 100/25 kV and 415V, 3 phase, 3/4 wire ac supplies, 240V and 110V, 1 phase, 2 wire ac supplies, at 50Hz and 110V dc equipment control supplies.

5.2 Earth Electrodes and Earth Systems

- 5.2.1 Earth Systems for Bulk In-feed Substations
- 5.2.1.1 Each bulk In-feed substation will be provided with earthing farms for both utility supplier and Metro system.
- 5.2.1.2 Connections to the earth farms will be through two 'Principal Connections' links by means of stranded insulated copper cables with a cross- section area calculated for the worst case conditions of earth current through marshalling earth bars in the area of the farms
- 5.2.2 Earth Systems for Substations
- 5.2.2.1 Each services Substation will be provided with an earth farm, of resistance less than 1 ohm, and connected to the substation earthing system through two 'Principal Connection' links by means of stranded insulated copper cables with a cross-section area calculated for the worst case conditions of earth current.
- 5.2.2.2 The substation earthing system is to be compliant with IEC 60364 and IEC 61312 or BS 1013
- 5.2.3 Earthing for Distribution Systems
- 5.2.3.1 Supplies at 415/240 V, or 110 V are made available for Depot and station equipment, and, where applicable, trackside equipment. These supplies are derived from the Secondary winding of the power source (Transformer/Generator etc) 415 V star- connected 3-phase supplies, the star point of which is to be bonded to the auxiliary Substation earthing system by PST contractor.

- 5.2.3.2 Continuity of this earth connection to the point of supply shall be provided by the cable sheath / armouring and/or additional bonding cables by PST contractor.
- 5.2.3.3 All locations receiving such supplies, which are remote from the earth system of any traction or distribution substation/ASS, are to be earthed by one of the following methods:
- a) by low impedance connection to the trunk earth system such that the minimum earth fault current is adequate to operate the over current protection in accordance with IEC 60364
 - b) where the requirement in (a) cannot be met, approved earth leakage protection is to be provided;
 - c) by connection of the earth terminal to the earth electrodes at any adjacent location via cable sheaths and armouring and/or additional bonding cables such that the earthing impedance meets the requirement in (a) above;
 - d) by connection of the earth terminal via sheaths and armouring of the supply cables or other bonding conductor to the earth system of the auxiliary substation, such that the earth fault loop is entirely metallic and of sufficiently low impedance to meet the requirement of (a) above.
- 5.2.3.4 The earthing of all distribution and sub-distribution systems is to be in accordance with IEC 60364.

5.3 System Earthing

5.3.1 General

- 5.3.1.1 This section describes the connection to earth of the neutral or negative, nominally equi-potential points of the current carrying conductors in each section of the power supply system.

5.3.2 100 kV (or as determined at the detail design stage) Supplies

- 5.3.2.1 The method of earthing of 100kV (or as determined at detail design stage), 3 phase supplies from utility supplier must be coordinated with utility supplier.

5.3.3 415V Supplies

- 5.3.3.1 The star point of the 415V secondary winding of the auxiliary transformer will be connected to the earth bar of the 415V switchboard by PST contractor.
- 5.3.3.2 The earth bar will be connected to the neutral bar via a neutral link in the switchboard by PST contractor.
- 5.3.3.3 The neutral bar of the transformer is to be solidly earthed, via a bolted link to the earth system by PST contractor.

5.3.4 240V Supplies

- 5.3.4.1 The 240 volt supplies are taken from one phase and the neutral of the above 415V supplies. The neutral shall be earthed in accordance with Clause 5.2.3

5.3.5 110V AC Supplies

- 5.3.5.1 The 110V supplies are obtained from 240/110V transformers. Each 110V winding of these transformers is to be fitted with a centre tap which is to be solidly earthed.
- 5.3.5.2 Approved earth fault detection equipment is to be provided.

5.3.6 110V DC Supplies

- 5.3.6.1 Both poles of the 110V battery supplies used in traction and distribution substations/ASS and elsewhere in connection with the power supply system are to be insulated from earth.
- 5.3.6.2 Approved positive pole and negative pole earth fault detection equipment is to be provided.

5.4 Equipment Earthing (non-track side)

- 5.4.1 This section refers to the treatment of metal enclosures or supporting metalwork for the equipment associated with the power supply systems covered in Section 5.2.3 above, with the exception of the trackside equipment which is covered in Section 5.5 below.
- 5.4.2 Earthing and bonding of electrical equipment is required to reduce the effects of interference, and to ensure the personal safety of the public, operational and maintenance staff by limiting the step and touch voltages to within acceptable limits. Where there is a conflict between these requirements, personal safety is always to take precedence.
- 5.4.3 33kV Cables / 25kV cables
 - 5.4.3.1 The earthing of screens and armouring of all 33kV and 25kV cables is to be earthed at both ends. Exception may be made at the extreme ends of the system to avoid any circulating currents detected in service.
 - 5.4.3.2 Means are to be provided for disconnecting the screen ends, individually, from earth for testing purposes.
- 5.4.4 Other Power Supply Cables
 - 5.4.4.1 This section covers the cables for the distribution of 415/240Vac supplies and 110Vdc Supplies
 - 5.4.4.2 The armouring of multicore cables (e.g. 3 phase or twin and earth etc.) is to be earthed at both ends via an earth terminal provided with the gland, or via the metalwork of the cable box and structure to the earth bar or terminal of the equipment at which the cable is terminated.
 - 5.4.4.3 Exceptions will be where the equipment at each end does not share the same earth system as, for example, the dc switchgear for which the enclosures are insulated from the substation earth and connected to it via a leakage current measuring shunt. In this case the armouring will be earthed only at the distribution board end.
 - 5.4.4.4 Single core cables are to be earthed in a similar manner but at one end only and must avoid circulating eddy currents where the metallic cable sheath is connected to a metallic cabinet.
- 5.4.5 100 kV/ 33 kV and 25 kV Switchgear
 - 5.4.5.1 All ac switchgear will be earthed directly to the substation earthing system.
- 5.4.6 415V, 240v and 110 V Switchgear
 - 5.4.6.1 All metallic components of the cubicles are to be bonded to an earth bar or terminal which is to be connected to the substation earth system.
- 5.4.7 Battery Equipment
 - 5.4.7.1 All metallic components of metal stands and cubicles for batteries, battery chargers and DC distribution switchboards are to be bonded to an earth bar or terminal which is to be connected to the earth system.

5.4.8 Transformer

5.4.8.1 All electrically separate parts of each transformer core are to be bonded together and the core as a whole is to be insulated from the enclosure/tank. An accessible removable link is to be provided between the core and the enclosure/tank for earthing the core for core testing.

5.4.8.2 All metallic components of control compartments are to be bonded to an earth terminal or bar, which is to be connected to the enclosure. The enclosure is to be connected to the substation earth system with a suitable fault rated earth connection.

5.4.9 415/110V Transformers

5.4.9.1 Each transformer is to be provided with a screen between the primary and secondary windings so that in the event of a fault, the primary winding or its connections cannot be connected to the secondary winding or its connections

5.4.9.2 The centre point of the secondary 110 V winding is to be connected to the substation earth system.

5.4.9.3 This screen, the core and framework of each transformer is to be connected to the earth bar or terminal of the enclosure in which the transformer is located.

5.4.9.4 The earth bar or terminal of the enclosure is to be connected to the substation earth system.

5.4.10 Marshalling Panels

5.4.10.1 All metallic components of each cubicle are to be bonded to an earth terminal or bar, which is to be connected to the earth system.

5.4.11 Instruments, Relays, Control Switches and other Electrical Components

5.4.11.1 All metallic cases and/or frames of instruments, relays, control switches and other electrical components mounted on control panels or in cubicles are to be connected to the earth bar or terminals of the cubicle in which the component is mounted.

5.4.12 Ancillary Equipment

5.4.12.1 Cubicles, cabinets, racks and panels are to be provided with a copper earth bar having a suitable cross-sectional area for the possible fault current, placed at a convenient position within the equipment. All metal parts, other than those forming part of an electrical circuit, are to be earthed by connection to the earth bar.

5.4.12.2 When apparatus or instruments are accommodated on panel cubicle doors or swinging frames, flexible cable or braid is to be used for earthing these items; the door hinges are not acceptable as means of earthing this part of the equipment. Except where otherwise approved, a stud type terminal of diameter not less than 12 mm, or a tapped boss of equivalent size, is to be provided on the outside of each cubicle or structure for the purpose of making the connection to earth. This terminal is to be connected to the substation earthing system.

5.5 Track and Trackside Equipment

5.5.1 Traction Return Running Rails (Main Lines)

- 5.5.1.1 The track rails, where used for traction return purposes in main line and Depot areas, have to be regularly bonded to the Buried Earth Cable. Maximum distance between two bondings should not exceed 500m. In Track circuited areas, the bonding will be through appropriate track circuit device.
- 5.5.1.2 As the Metro system uses the train wheels and track rails for the traction current return circuit, the rails electrical continuity has to be ensured. Whenever the rails continuity is not ensured, mechanical joints for signalling purpose, expansion joints for track purpose only, the rail's continuity shall be recreated using continuity bonds
- 5.5.1.3 Concerning the expansion joints for track purpose only, the continuity will be ensured by 2* 70mm² (minimum cross section) cables bolted (or cad welded as agreed by the Engineer) on the rails. The drilling (if agreed by the Engineer) and the preparation of rail bonds shall be done in factory.
- 5.5.1.4 Concerning the mechanical joints for signalling purpose, the continuity will be ensured by impedance bond.
- 5.5.1.5 As the Metro system uses the train wheels and track rails for the traction current return circuit, the track rails will have volt drop along them as a result of the flow of traction current. The rails are imperfectly insulated from earth or the structures on which they are fixed and therefore a circuit parallel to the rails can occur by means of which current driven by the volt drop flows out of and back into the rails. The current, which flows out of the rails and returns at some other point, is referred to as stray current.
- 5.5.1.6 The most serious effect of the stray current is electrolytic corrosion at the point where current flows out of a metal surface into concrete or soil. An equivalent of an Electrolytic circuit is formed the same as a battery cell is set up at the interface, the potential of which varies with the ground, structure and rail materials present. For corrosion to take place the interface potential must exceed the potential of the cell.
- 5.5.1.7 The rails shall be properly bonded to Buried Earth Cables so that Buried Earth Cable nominally constitutes the return path and limits the stray currents.
- 5.5.1.8 Track rails, Buried Earth Cables, Aerial Earth cables, Earth pits will be connected together via Integral Transverse Bonds provided:
- with a maximum 500 meter spacing
 - at mechanical joints.

Spacing will be determined by the PST Contractor in his EMI study.

5.5.2 Clearance To Earthed Equipment or Structures

- 5.5.2.1 Any exposed, non live, conductive part (metallic structure or other equipment), which is closer than 2.0m from vehicle static envelope shall be earthed to the Buried Earth Cable. If already part of an earthing system, the conductive part should be connected to the buried earth cable via voltage limiting device.
- 5.5.2.2 Screen doors on station platforms will be bonded to the track by duplicate insulated cables and insulated from the general body of earth. Metal enclosed electrical equipment within 2.5 metres of the screens will not be earthed but

the enclosed live equipment 'double insulated' from the enclosure.

- 5.5.2.3 The station platform surface in the vicinity of the screen doors will be of insulating material

6. EARTHING OF COMMUNICATION AND CONTROL SYSTEMS

6.1 General

- 6.1.1 There are several separate sub-systems which collectively form the control and communications system. Equipment, enclosures and mountings associated with these sub-systems are distributed throughout the Metro system at trackside, stations and depot locations.
- 6.1.2 The equipment, enclosures and mountings associated with the control and communications system are not anticipated to be located within 2m of any part of the Metro system that is intentionally connected to the traction return system. Earthing of the control and communications system will thus be by conventional methods to the protected earth of the distribution switch board ..
- 6.1.3 Should it become necessary, during construction, to locate any item of equipment associated with the control and communication system within 2m of a part of the Metro system that is connected to the traction return system then additional protective measures will need to be adopted. In such instances the provisions of clause 7.1, to limit the touch potential between the two earth systems, will apply, and the equipment enclosure will be earthed to the Buried Earth Cable through voltage limiting devices.
- 6.1.4 Two separate clean earths of value not exceeding 0.5 Ohms required at each station for signalling and telecommunication (including AFC), are to be terminated in signal, telecom and AFC equipment rooms as well as in telecom closets rooms at all stations, depot and OCC.

6.2 Trackside Equipment

- 6.2.1 Trackside equipment is considered to comprise all equipment, enclosures and mountings located at stations, substations and adjacent to the track but, remote from stations and substations.
- 6.2.2 Integral Transverse Bonds and insulated joints
- 6.2.2.1 The integral transverse bonds have to be connected at a maximum spacing of 500m. These integral transverse bonds will also serve the need of equipotential link.
- 6.2.2.2 Insulated joints are mandatory on track at traction substations
- 6.2.3 Station Locations
- 6.2.3.1 At each station a UPS and UPS distribution switchboard will be provided by a designated contractor.
- 6.2.3.2 Each item of control and communications equipment that is connected to a 240V single phase supply derived from this source is to have its earth terminal directly connected to the main protected earth terminal at the distribution board by an appropriate protective conductor
- 6.2.3.3 All metalwork (including enclosures, mountings, racks, trays etc.), associated with an item of control and communications equipment that is not intended to

carry current is to be bonded to the earth terminal within the equipment enclosure and extended to distribution board by an appropriate conductor.

- 6.2.3.4 Alternatively, if the design of the equipment requires, a direct earth cable, to the station earth farm principal earth connection, may be provided.

6.2.4 Trackside Locations

- 6.2.4.1 Control and communication equipment at trackside locations, e.g. points machines etc, are to derive their power supply from the UPS of the nearest station or the depot as appropriate.

- 6.2.4.2 Each item of control and communications equipment that is connected to a 240V single phase supply derived from this source or otherwise is to have its earth terminal directly connected to the main system earth cable running between the earth systems of successive auxiliary substations. In these cases the earth core of the supply cable will be left open at the end remote from the supply to avoid excessive currents during fault conditions.

- 6.2.4.3 All metal work (including enclosures, mountings, etc.), associated with an item of control and communications equipment that is not intended to carry current e.g. signal lamp enclosures etc., is to be bonded to the main system earth cable running between the earth systems of successive auxiliary substations.

- 6.2.4.4 The touch potential of the trunk earthing conductor will be controlled as described in clause 5.5.2 above.

6.2.5 Substation locations

- 6.2.5.1 Control and communication equipment, housed within or immediately adjacent to Sub-stations, are to derive their power supply by dedicated feed from the UPS of the station or depot as appropriate.

- 6.2.5.2 Each item of control and communications equipment that is connected to a single phase supply derived from this source is to have its earth terminal directly connected to the protective earth terminal at the distribution board.

- 6.2.5.3 All metalwork (including enclosures, mountings etc.), associated with an item of control and communications equipment that is not intended to carry current shall be bonded to the equipment earth terminal.

- 6.2.5.4 The earth terminal of the distribution board will be connected to the distribution switchboard protective earth.

6.3 Depot Equipment

Depot equipment comprises all control and communications equipment contained within the Depot building and that located in the stabling yard and mounted on the depot buildings.

6.3.1 Signalling and Telecommunications Room

- 6.3.1.1 Equipment contained within the signalling and communications is to be fed from the UPS distribution board, installed complete with protective devices and earth terminal

- 6.3.1.2 Power distribution to the various items of ancillary equipment and cubicles shall be by means of several ring main circuits. Each circuit contains a dedicated protective conductor (separate conductor or cable armouring) connected to the protected earth terminal at the distribution Switchboard.

- 6.3.1.3 All items of control and communication equipment are to have a direct connection between the equipment earth terminal and the circuit protective conductor.
- 6.3.2 Operations Control Centre
 - 6.3.2.1 Equipment contained within the Control centre is to be fed from the UPS distribution board, installed complete with protective devices including surge suppressor and earth terminal.
 - 6.3.2.2 Power distribution to the various items of ancillary equipment and desks shall be by means of several ring main or radial circuits. Each circuit contains a dedicated protective conductor (separate conductor or cable armouring) connected to the protected earth terminal at the distribution switchboard.
 - 6.3.2.3 All items of control and communication equipment are to have a direct connection between the equipment earth terminal and the circuit protective conductor.
- 6.3.3 Other Depot Locations.
 - 6.3.3.1 Control and communication equipment, located externally or on depot buildings, is to derive its power from the control centre UPS.
 - 6.3.3.2 Internal earthing of the equipment will be to a dedicated earth terminal connected to the enclosure.
- 6.3.3.3 Where the equipment is outside the 3.0m limit to the vehicle static envelope an earthing circuit for the metallic enclosure will be provided back to the protected earth of the distribution switchboard. Where the equipment is within the 2.0 m limit the enclosure will be earthed to the depot system earth. The touch potential of this earth system will be controlled by strategically situated voltage limiting devices as described in 5.5.2 above.

7. EARTHING OF OTHER METALLIC STRUCTURES

7.1 General

- 7.1.1 Other metallic structures comprise those structures which do not form part of the Power Supply or Communication and Control Systems covered in Section 4 and 5 above. They include the reinforcing in concrete construction, pipes for other services and fixtures and fittings in buildings and stations and depot.
- 7.1.2 Lightning protection of structures and buildings is also included in this Section.
- 7.1.3 The ac systems are generally arranged to operate with their neutrals earthed, and with associated metallic enclosures also connected to earth, by conventional methods.
- 7.1.4 The Buried Earth Cable shall be regularly earthed and connected to earth pits.
- 7.1.5 Earth pits shall be provided at each stations and their spacing should not exceed 300m in depot. Earth pits earthing value shall not exceed 1 Ohm.
- 7.1.6 Earth pit shall be provided with disconnecting bars so that their earthing value can easily be checked.
- 7.1.7 Any exposed metallic structure, concerned by 7.1.1, which is closer than 10m from the Over Head Line shall be earthed to the Buried Earth Cable as per clause 5.5.2.1.

- 7.1.8 The self-restoring properties of high voltage limiting devices avoid a permanent leakage path for limited faults whereas a latched contactor needs to be manually reset or a device needs to be physically replaced.

7.2 Over ground Structures

- 7.2.1 The frames of all buildings and other structural steelwork are to be bonded to the local earth system unless all parts of the frame or structure are completely encased in concrete, masonry or other non-metallic cladding.
- 7.2.2 Where a local earth system is not provided such a system is to be provided for the purposes of this Clause in those locations where accidental contact with the traction system is possible. Such an earth system is to have an overall resistance not exceeding 10 ohms between any point of the earthed frame or structure and the general body of the earth. In addition a self-restoring spark gap device is to be connected between each separate structure and the traction return system.
- 7.2.3 In the case of the building structure of the Depot workshop, where the traction return system is deliberately earthed, the structure E&M service and traction earthing systems are all to be interconnected.
- 7.2.4 In general the reinforcing bars in concrete structures or foundations are not to be earthed in those cases where the reinforcing bars are completely encased in concrete. This applies to substation foundation slabs.
- 7.2.5 Where external connections are made to the reinforcing, for the purpose of providing studs for securing metallic structures or components which are earthed, insulating sleeves and washers are to be fitted to the studs if there is a possibility of traction return currents passing into the reinforcing via the studs.

7.3 Reinforced Concrete Track slab

- 7.3.1 The reinforced track slab will incorporate separate dedicated stray current collection mats of rebar construction, for each track.
- 7.3.2 These stray current collection mats will be linked to each other in succession by disconnectable links. At each link position one side of the link will be connected to a trunk 'stray current collection/monitoring cable' of suitable section.
- 7.3.3 The trunk collection cable will be duplicated for each track and each terminated at both ends on insulators adjacent to the station earthing system with the possibility of connecting to the earth system through diodes for stray current collection if later deemed beneficial.
- 7.3.4 The diodes shall be provided at the outset and installed together with the connection terminals such that they can be connected or not as may be required.
- 7.3.5 The stray current collection/monitoring cable will be insulated and protected from earthed metal along its route.
- 7.3.6 All trackslab reinforcing in the workshop area, where the tracks are earthed, shall be bonded to the earthed rebar and steel structures of the workshop building.

7.4 Services to Metro system premises.

- 7.4.1 Metallic service (I.e. water, gas, waste water etc) pipes entering the Metro system premises, both over and underground, are to be provided with an insulated insert at the point of entry, and the pipe work within the Metro system is to be bonded to the local earth system.
- 7.4.2 Where both plastic and metal pipes are used, all lengths of exposed metal pipes,

or those connected to taps or apparatus, are to be bonded to the local earth system. A separate bond is not required for the pipe if it is electrically continuous with earthed apparatus.

7.5 Small Metallic Components

- 7.5.1 Small metallic and isolated structural parts which are effectively segregated from any electrical apparatus or cables etc. or earthed metallic enclosures and structures do not require to be bonded to the local earth system.
- 7.5.2 For the purposes of this Clause the metal angle supports for trench covers and similar metalwork in electrical traction and distribution substations/ASS are not effectively segregated and are to be bonded to the substation earth system.

7.6 Depot Fencing

- 7.6.1 Metallic fencing associated with the Metro system within 2.0 metres of the track or any part of any structure or other equipment which is connected to it, is to be earthed to the depot slab structural earth system.
- 7.6.2 The depot Substations will also derive their earthing from the depot slab structural earth system
- 7.6.3 Metallic fencing associated with the Metro system within 10.0 metres of the overhead contact line, is to be earthed to the Buried Earth Cable.
- 7.6.4 Each separate section of fencing is to be separately earthed in the appropriate manner as above.
- 7.6.5 All gate posts are to be bonded to each other across the gate opening by an underground conductor, and the gates themselves bonded across the hinges.

7.7 Lightning Protection

- 7.7.1 The need for lightning protection for individual mass transit system buildings is to be assessed in accordance with IEC 61024-1 or BIS: 2309 or the local building code. Where lightning protection is found to be necessary, it shall be provided in accordance with this Standard.
- 7.7.2 All building structures will be of steel or steel reinforced concrete with every pillar of the structures bonded into the structure earth of the depot
- 7.7.3 Metal roofing will be multiple bonded into the metal of the building structure. Lightning conductors will be provided to bridge any non-metallic roofing and conduct into the steel structure in the most efficient manner.
- 7.7.4 Cables with metal sheaths and other metallic services entering the building are to be bonded to the structure at the point of entry and to any electrodes provided for lightning protection, if not already adequately bonded via the local earth system.

8. CORROSION CONTROL

- 8.1 The measures to be used to reduce corrosion and other interference effects are:
 - i) to ensure that the along-track resistance is as low as practicable;
 - ii) to ensure that the track-to-buried earth resistance is as low as possible,
 - iii) in slab track sections, to provide a substantial buried collector mat to intercept a high percentage of traction leakage currents (stray current) and return them to buried earth collector.

Maha Metro



Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 17 – Adjacent Works Contracts

June 2018

ADJACENT WORKS CONTRACTS

The Construction Projects (adjacent works contracts) that are to be undertaken adjacent to the site area shall have to be identified by the Contractor with which the Contractor shall be required to interface.

The Contractor should be fully responsible for identifying and interfacing with all adjacent works projects. The information that might be available with Employer in this respect can be shared with the Contractor.

Currently identified adjacent work Contracts are as defined below :

1. Swargate Station Multistoried development - Contractor shall liaise with them and consider necessary input in underground station permanent structural design. Vis-a-viz shall respect their requirements.

Maha Metro



Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 18 – Schedule Of Dimension

(Provisional SOD)

June 2018

MAHA METRO



MAHARASHTRA METRO RAIL CORPORATION LIMITED

(A JOINT VENTURE OF GOVT. OF INDIA & GOVT. OF MAHARASHTRA)

SCHEDULE OF DIMENSIONS

FOR

STANDARD GAUGE
(1435 MM)

(25 kV AC OHE TRACTION)
(FOR 2900 MM WIDE STOCK)

(ELEVATED, AT-GRADE & UNDERGROUND SECTION)

VERSION-A
FEBRUARY 2018

MAHARASHTRA METRO RAIL CORPORATION LIMITED

The Orion Building, 1st Floor, 5, Koregaon Road,
Pune - 411001

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SCHEDULE OF DIMENSIONS

STANDARD GAUGE (1435 mm)

PREAMBLE

Pune Metro rail has adopted Standard Gauge with 25 kV AC OHE Traction System. The Schedule of Dimensions has been prepared based on following factors: -

1. The Kinematic Envelope and other infringements have been calculated for 2900 mm wide and 4048mm high (pantograph in locked down position) rolling stock, based on the Kinematic Envelope calculations. The track and vehicle maintenance shall conform to the clearances indicated therein, during the period these Rolling Stocks are in operation.
2. Track shall be maintained to the tolerances taken for calculation of Kinematic Envelope.
3. The clearances are based on assumption that windows are sealed, and all doors are closed during movement / operation.
4. The Structure Gauge indicated in the SoD shall not be violated under any circumstances except for platform coping, platform gate, track access gate, platform screen doors and hand railing in back-of-house of platform edge.
5. The Kinematic Envelope(s) indicated in the SoD shall not be violated under any circumstances.
6. The Vehicle Kinematic Envelope for 40 Kmph shall be applied only within the confines of stations. At all other locations, the Kinematic Envelope corresponding to 90 kmph vehicle speed with 100 kmph side wind speed shall be used for determining the Structure Gauge and Electrical clearances.
7. The maximum speed for passenger operation shall be 80 kmph.
8. Maximum operating speed at platform shall be 40 kmph and Kinematic Envelope will not be infringed under any circumstances.
9. This SoD is applicable for ballasted/ballastless track on mainline and ballasted/ballastless track in Depots.
10. For evacuation of passengers, in case of emergency, including in cases of derailment of the end coaches, emergency doors provided at both ends (front & rear) of the train shall be used for evacuation. The emergency doors will open and rest between or onto the track-plinth and the space available between the track-plinths shall be used as walkway. The evacuation will be done under the supervision of train operator and/or station staff.
11. No workman/equipment/structure is allowed between vehicle and structure gauge during operation/movement of train.

INTRODUCTION

The dimensions given in this Schedule of Dimensions are to be observed in all works on 1435 mm gauge (STANDARD GAUGE), unless prior sanction has been obtained from the Railway Board through the Commissioner of Metro Railway Safety/Chief Commissioner of Railway Safety (as per applicability) to execute works which infringe this Schedule of Dimensions.

This Schedule of Dimensions is applicable to Elevated, At-Grade and Underground sections of Pune Metro Rail, which shall be with 25 kV AC Traction system and Over Head current collection. The Rolling Stock shall be 2900 mm wide and 4048 mm high (maximum with pantograph in locked down condition or without pantograph) with sealed windows and doors closed while in motion.

Elevated Systems shall be with suitable over ground structure such as Viaduct. Elevated section shall have suitably designed Ballastless (DFF) Track. The Underground System maybe with a circular tunnel or Rectangular box or of any other suitable shall have suitably designed Ballastless (DFF) Track. The At-Grade system and the Depot area may have either Ballasted Track or Ballastless Track.

The Schedule of Dimensions (SoD) has been divided into five chapters as under

Chapter-I	-----	General
Chapter-II	-----	Stations
Chapter-III	-----	Rolling Stock
Chapter-IV	-----	Electric Traction
Chapter-V	-----	Platform Gate / Platform Screen doors

CHAPTER-I

GENERAL

1.1 SPACING OF TRACKS

Minimum centre to centre distance of tracks without any structure in between tracks for tangent (straight) track for:

(a) Elevated sections and At-grade sections.....3650 mm

(b) Underground Sections.....3500 mm

Note: See Appendix-1 for minimum track centers distance on curves.

1.2 CURVES

1.2.1 Minimum radius of curves (horizontal)

i) On main running lines

(a) Elevated and At-Grade Sections	120 m
(b) Underground Section	200 m
(c) Underground Sections (Desirable)	300 m

ii) Depot and other non-passenger Lines 100 m

iii) At passenger platforms 1000 m

1.2.2 Check Rail / Restraining Rail

Check Rail / Restraining Rail shall be provided on curves on main line where radius is 190m or less. Check rail/Restraining rail shall not be mandatory for curves in depots, yards and non-passenger lines, where speed is less than 25 kmph. The clearance between check rail/restraining rail and running rail shall be suitably decided by metro depending upon study of track vehicle interaction.

1.2.3 Minimum radius of Vertical Curve

On Main Line	1500 m
--------------	--------

Note: 1. Minimum length of Vertical Curve - 20 m

2. No vertical curve shall be provided in platform area.

1.2.4 Cant and Cant Deficiency

a) Maximum Cant on curves	110 mm
b) Maximum Cant Deficiency	85 mm

1.3 GRADIENTS

1.3.1 The maximum grade (compensated) shall be 4%.

Note:

(i) There will be no change of gradient in transition portion of curves.

(ii) The gradient will be compensated for curvature at the rate of 0.04% per degree of curve.

1.3.2 Maximum permissible gradient on turnouts

- | | | |
|------|----------------------|-------|
| (i) | On Ballasted Track | 0.25% |
| (ii) | On Ballastless Track | 2.5% |

Note:

- (i) There shall be no change of gradient (i.e. Vertical curve) on and within 15.0m (desirable)/3.0 m (minimum) of any turnout on Ballastless track. In case of ballasted track, there shall be no change of grade on and within 30 meters of any turnout.
- (ii) There shall be no horizontal curve within 15.0m (desirable)/3.0 m (minimum) of any turnout on Ballastless track and 30 meters of any Turnout on Ballasted Track.
- (iii) Turnout shall normally be installed on straight track. In exceptional situations, turnout may take off from curve provided that the radius of lead curve (main line as well as diverging line) is not less than 190m. The negotiability of rolling stocks on such turnout must be certified by rolling stock supplier and confirmed through oscillation trial and a suitable speed restriction should be imposed on main and/or diverging track based on track geometry and other considerations, if required. In case of turnout installed on curved track, the minimum distance from commencement of vertical curve or another horizontal curve shall be 15m for Ballastless track. Turnout shall not be laid on transition curve.
- (iv) The limit of turnout for above purposes shall be taken from Stock Rail Joint (SRJ) to end (i.e heel) of crossing for Ballastless track. For Ballasted track, it shall be from SRJ to last common sleeper behind end of crossing.
- (v) The maximum permissible gradient on turnout and the location of turnout with respect to vertical/horizontal curves in vicinity shall be confirmed from rolling stock supplier for the negotiability of rolling stock.
- (vi) The above stipulations shall also be applicable for turnout to be laid outside station limit, if any.

1.4 BUILDINGS AND STRUCTURES

- 1.4.1 Minimum horizontal distance from centre of track to any structure (except at passenger platform) for heights above rail level on level/constant grade tangent track shall be as under: -

(a) Elevated and At-Grade Sections

<u>Height from rail level</u>	<u>Horizontal distance from C.L. of track</u>
i. Up to 65 mm	1465 mm
ii. 65 mm to 200 mm	1465 mm increasing to 1640 mm
iii. 200 mm to 305 mm	1640 mm
iv. 305 mm to 930 mm	1640 mm increasing to 1735 mm
v. 930 mm to 1095 mm	1735 mm increasing to 1740 mm

vi.	1095 mm to 3310 mm	1740 mm increasing to 1825 mm
vii.	3310 mm to 3775 mm	1825 mm decreasing to 1546 mm
viii.	3775 mm to 6200 mm	1546 mm

Also refer to Figure No. PMSG-2

(b) Underground Sections

(i) Circular Tunnels

Height from rail level	Horizontal distance from C.L. of track
i. Up to 65 mm	1465 mm
ii. 65 mm to 200 mm	1465 mm increasing to 1585 mm
iii. 200 mm to 305 mm	1585 mm
iv. 305 mm to 940 mm	1585 mm increasing to 1670 mm
v. 940 mm to 1095 mm	1670 mm increasing to 1675 mm
vi. 1095 mm to 3305 mm	1675 mm increasing to 1740 mm
vii. 3305 mm to 3965 mm	1740 mm decreasing to 1250 mm
viii. 3965 mm to 4775 mm	1250 mm
ix. 4775 mm to 5070 mm	1250 mm decreasing to zero along an arc of circle of radius of 2900 mm

Also refer to Figure No. PMSG-09

(ii) Rectangular Box Tunnels

Height from rail level	Horizontal distance from C.L. of track
i. Up to 65 mm	1465 mm
ii. 65 mm to 200 mm	1465 mm increasing to 1585 mm
iii. 200 mm to 305 mm	1585 mm
iv. 305 mm to 940 mm	1585 mm increasing to 1670 mm
v. 940 mm to 1095 mm	1670 mm increasing to 1675 mm
vi. 1095 mm to 3305 mm	1675 mm increasing to 1740 mm
vii. 3305 mm to 3965 mm	1740 mm decreasing to 1250 mm
viii. 3965 mm to 4838 mm	1250 mm

Also refer to Figure No. PMSG-09

Note:

- Extra clearances shall be provided for curves as laid down at Para-1.7.
- The term 'structure' covers any item including light ones like ladders, isolated posts, cables etc. erected alongside the track except for passenger platform.
- Minimum lateral clearance for OHE masts for tangent track shall be 2150 mm from centre line of nearest track.
- Minimum lateral clearance for OHE masts for tangent track at depot shall be 1950 mm from centre line of nearest track.
- For passenger platform and PSD, refer to Para-2.2.1 to 2.2.3 of Chapter-II and Chapter-V respectively.

1.5 KINEMATIC ENVELOPE

For the Kinematic Envelope for level or constant grade tangent track, refer to:

- a) Figure No. PMSG-1 for At-Grade and Elevated Sections
- b) Figure No. PMSG-1A for At-Grade and Elevated sections at passenger platform.
- c) Figure No. PMSG-08 for Underground Section (Outside stations)
- d) Figure No. PMSG-11 for Underground section at Passenger Platform

Note:

Extra clearances shall be provided for curves as laid down at Para-1.7

1.6 STRUCTURE GAUGE

(a) Elevated and At-Grade Sections

The Structure Gauge (Fixed Structure Line) has been arrived at by allowing minimum clearance of 150 mm to Kinematic Envelope and minimum electrical clearance of 320mm from 25 kV live parts conforming to the stipulations in Chapter-IV of this SoD.

Refer to Figure No. PMSG-2 for Structure Gauge for outside stations on level or constant grade tangent track.

(b) Underground Section

The Structure Gauge (Fixed Structure Line) has been arrived at by allowing minimum clearance of 100 mm to Kinematic Envelope and minimum electrical clearance of normally 270 mm from 25 kV live parts conforming to the stipulations in Chapter-IV of this SoD.

Refer to figure No. PMSG-09 for structure Gauge for Underground sections (Outside stations) with ballast less track for level or constant grade tangent track.

Note:

Extra clearances shall be provided for curves as laid down at Para-1.7

1.7 EXTRA CLEARANCES ON CURVES

Following are the extra clearances considered for curves.

Abbreviations used in Para-1.7:

- C is the distance between centres of bogies in meters,
- C₁ is the coach (vehicle) length in meters,
- R is the radius of curve in meters,
- Ca is the Cant applied in mm,
- h is the height from rail level in mm and
- g is the distance between centres of rails in mm

1.7.1 INSIDE OF CURVE

A. Curvature effect

- i) Mid throw at the center of the vehicle = V (in mm) = $125 \times C^2 / R$

- ii) Clearance due to gauge widening on curves

For values of items (i) and (ii) above, refer to Appendix-2

Note:

Lateral shift of 26 mm due to nosing is included in Kinematic Envelope for tangent track (and as a result, included in Structure Gauge also) shall be subtracted from the total extra clearance worked out as at Para-1.7.1(A)-i & ii above for inside of a curve in case the value of mid throw (V) is equal to or greater than 26 mm. In case the value of mid throw (V) is less than 26 mm, the curvature effect shall be due to widening of the gauge only. (The Mid throw minus 26 mm shall be taken as zero).

B. Clearance for Cant

Underground (Box Structure), Elevated and At-Grade Sections

The lean 'L' due to Cant at any point at height 'h' above rail level is given by:

$$L = Ca \times h/g \text{ (all in mm)}$$

For values of Structure Gauge (E_1) for inside of a curve with cant effect only, (as shown in Figure No. PMSG-3A), refer to Appendix-3A for Elevated and At-grade Sections and Appendix 3(UG) for Underground Sections.

Circular Tunnels

In the case of circular tunnel, cant is provided by raising the outer rail and suitably shifting the center of the circular tunnel towards inside of curve and upwards. This has same effect as assuming rotation of the circular tunnel about mid-point of top of inner rail resulting in shift of Tunnel center laterally towards inside of curve and also vertically upwards.

The Rigid OCS shall also be rotated with the tunnel so as to be along the center line of canted track

For values of horizontal and vertical shifts of center of circular tunnel for different values of cant, refer to Appendix-5.

C. Clearance for vertical curve (vertical throw)

Vertical Throw V_1 and V_2 (in mm) for vertical curve shall be calculated as under:

V_1 (with vehicle centre in sag or vehicle end on summit)

$$= 125xC^2/R$$

V_2 (with vehicle centre on summit or vehicle end in sag)

$$= (125xC_1^2/R)-(125xC^2/R)$$

For values of vertical throw V_1 & V_2 due to vertical curves of different radii, refer to PMSG-4.

1.7.2 OUTSIDE OF CURVE

A. Curvature effect

$$\begin{aligned} \text{i) End throw at the end of vehicle} &= V_o \text{ (in mm)} \\ &= [125xC_1^2/R] - [125xC^2/R] \end{aligned}$$

ii) Clearance due to gauge widening on curves

iii) Additional nosing due to gauge widening on curves

The values of items (i) to (iii) are shown in Appendix-2

B. Clearance for Cant

a) Underground (Box structures), Elevated and At-Grade sections

The lean 'L' due to Cant at any point at height 'h' above rail level is given by:

$$L = (-) Ca \times h/g \text{ (all in mm)}$$

-ve sign indicates relief due to cant or reduction in clearance required.

Note:

Full relief for lean due to cant (Ca) is to be taken into account only for calculation of track spacing without any structure between tracks. In case there is a structure adjacent to track, relief for lean is to be taken into account only if the cant provided is greater than 50 mm and shall be limited to a value = $(Ca - 50) \times h/g$.

For values of Structure Gauge (F_1) on outside of curve with Cant effect only (as shown in Figure No. PMSG-3A), refer to Appendix-3A for Elevated and At-Grade Sections and Appendix-3 (UG) for Box tunnel sections.

b) Circular Tunnel

In the case of circular tunnel, cant is provided by raising the outer rail and suitably shifting the center of the circular tunnel towards inside of curve and upwards. This has same effect as assuming rotation of the circular tunnel about mid-point of top of inner rail resulting in shift of Tunnel center laterally towards inside of curve and also vertically upwards.

The Rigid OCS shall also be rotated with the tunnel so as to be along the center line of canted track.

For values of horizontal and vertical shifts of center of circular tunnel for different values of cant, refer to Appendix-5.

C. Clearance for vertical curve (Vertical throw)

The provisions at Para-1.7.1 (C) above shall be applicable in this case also.

For values of vertical throws V_1 & V_2 due to vertical curves of different radii, refer to PMSG-4.

1.8 MINIMUM TRACK SPACING ON CURVES

Underground Section, Elevated and At-Grade sections:

The worst case will be when the end of a bogie carriage on the inner track is opposite the center of a similar carriage on the outer track.

1.8.1 Without any structure between tracks

The minimum track spacing on curves without any structure between tracks shall be the sum of the following:

- i) $(E + F)$,
- ii) T_1 (Extra lateral clearance due to curvature on inside of curve)
- iii) T_2 (Extra lateral clearance due to curvature on outside of curve)
- iv) Minimum clearance between adjacent Kinematic Envelopes stipulated is as under:-
300 mm for Elevated and At-Grade Sections
200 mm for Underground Section

Where,
'E' is the distance from vertical axis of center line of canted track to canted Kinematic Envelope on inside of curve at a height 'h' (from rail level) for a given cant (Figure No. PMSG-3)

and

'F' is the distance from vertical axis of centre line of canted track to canted Kinematic Envelope on outside of curve at a height 'h' (from rail level) for a given cant (Figure No. PMSG-3)

Notes:

- i) The value of 'F', calculated from the formula at Figure No. PMSG-3 includes full relief due to Cant.
- ii) The sum of 'E' and 'F' for same height (which are with Cant effect only) shall be the maximum of values calculated for various heights from rail level.

For values of E, F, T_1 and T_2 , refer to the Appendices as shown below:

SECTIONS	For E & F	For T_1 & T_2
Underground	4 (UG)	2
Elevated and At-Grade	1. 3 for 90 kmph KE 2. 3i for 40 kmph KE	2

1.8.2 With a structure between adjacent tracks

The minimum track spacing on curves with a structure between tracks shall be the sum of the following:

- i) $(E_1 + T_1)$ Minimum clearance to the structure from center line of track on inside of curve (for outer track)
- ii) $(F_1 + T_2)$ Minimum clearance to the structure from center line of track on outside of curve (for inner track)

iii) Width of structure between adjacent tracks (measured across the tracks).

Where,

E_1 is the horizontal distance from vertical axis of centre line of track to canted Structure Gauge on inside of curve for a given cant, (Ref Fig no: PMSG-3A)

F_1 is the horizontal distance from vertical axis of centre line of track to canted Structure Gauge on outside of curve for a given cant, (Ref Fig no: PMSG-3A)

T_1 is extra lateral clearance due to curvature on inside of curve

T_2 is extra lateral clearance due to curvature on outside of curve.

Notes:

- (i) The values of ' E_1 ' and ' F_1 ' for a given cant C_a , shall each be the maximum of values at different heights of structure from rail level. In case the cant provided is greater than 50 mm on inner track, the value of F_1 shall be for the cant of $(C_a - 50)$ mm. In case the cant provided is 50 mm or less on inner track, the value of F_1 shall be for ZERO cant.
- (ii) Minimum track spacing, so worked out with a structure between the adjacent tracks shall not be less than that calculated as per Para 1.8.1 for tracks without any structure between adjacent tracks.

For values of E_1 , F_1 , T_1 and T_2 , refer to the Appendices as shown below:

SECTIONS	For E_1 & F_1	For T_1 & T_2
Underground	3 (UG)	2
Elevated and At-Grade	1. 3A for Structure Gauge corresponding to 90 kmph KE. 2. 3Ai for Structure Gauge corresponding to 40 kmph KE.	2

1.8.3 Pathways / Walkways for Underground Sections

A) Minimum width of Pathway / Walkway = 552mm

B) Minimum height of Pathway / Walkway = 1000mm

C) Maximum height of Pathway / Walkway = 1200mm

Note: Extra allowance shall be provided for curves as laid down at Para 1.7

- (i) Maximum and Minimum heights of pathway / walkway on curves are above inner rail.

- (ii) No Structure, other than signaling and minor signaling equipment post, shall be permitted within the minimum width of pathway / walkway.
- (iii) Minimum clearance to pathway / walkway at the nearest edge from kinematic envelope shall be 100mm for underground sections.
- (iv) Pathway / walkway could be used by metro inspection group only in non-operation periods and for evacuation of passengers in emergency.

1.9 DERAILMENT GUARD

- (a) Derailment Guard shall be provided on inside/outside of running rail in viaduct and in tunnels at locations specified by the Metro Railway. In tunnels, the derailment guard should preferably be provided inside the track, so that it permits less sway of coach towards tunnel wall in case of derailment.
- (b) Lateral Clearance between the running rail and the derailment guard shall be 210 ± 30 mm. It shall not be lower than 25 mm below the top of running rail and shall be clear of the rail fastenings to permit installation, replacement and maintenance.

Note:

In case of Double Resilient Base Plate Assembly Fastening System as approved by MoR, the lateral clearance between running rail and the derailment guard shall be 250 ± 20 mm.

CHAPTER - II

STATIONS

2.1 SPACING OF TRACKS AT STATIONS

Minimum spacing of tracks at station on straight and on curve of radius of 1000 m and flatter, without any structure between tracks

- | | |
|---|---------|
| (a) Elevated sections and At-grade sections | 3700 mm |
| (b) Underground Sections | 3900 mm |

Note:

‘Station Limits’ means platform portion only from SoD point of View

2.2 PLATFORMS

2.2.1 Maximum horizontal distance from centre of track to face of passenger platform coping for tangent track

- | | |
|-----------------------------------|---------|
| (i) For Elevated/At-Grade section | 1525 mm |
| (ii) For Underground Section | 1515 mm |

2.2.2 Minimum horizontal distance from centre of track to face of passenger platform coping for tangent track

- | | |
|-----------------------------------|---------|
| (i) For Elevated/At-Grade section | 1520 mm |
| (ii) For Underground Section | 1510 mm |

Notes:

- a) Platform faces shall be flared away smoothly from the centre line of the track at either end for a distance of 1500 mm beyond passenger area so as to give from centre of track a dimension:
 - 1590 ± 5 for At grade and Elevated Stations
 - 1575 ± 5 for Underground Stations
- b) For additional clearance for platforms on curves, refer to Para-2.7
- c) The track access gates at the end of platform up to a height of one meter from top of platform shall not infringe the Kinematic Envelope.

2.2.3 Height above rail level for passenger platform:

	<u>Maximum</u>	<u>Minimum</u>
(a) Ballasted Track	1085 mm	1075 mm
(b) Ballastless Track (DFF)	1095 mm	1085 mm

- 2.2.4 (i) Minimum horizontal distance of any isolated structure on a passenger platform from the edge of coping except platform gate / track access gate / PSD provided in the flared portion of the platform end. 2500 mm
- ii) Minimum horizontal distance of any continuous structure on a passenger platform from the edge of coping except platform gate / track access gate / PSD provided in the flared portion of the platform end. 3000 mm

Notes:

- a) Platform screen door (PSD) maybe installed at platform as per design of PSD but shall have minimum clearance of 10 mm from the kinematic envelope.
- b) The structure on the platform is treated as isolated if the length along the platform length is 2000 mm or less. Any structure having a length exceeding 2000 mm is treated as continuous structure. The clocks/mirrors/CCTV screens etc shall not be considered structures and shall be located at a minimum horizontal distance of 1000 mm from platform edge/coping with minimum height of 2000 mm from top of platform.
- c) For platform structure setting out dimensions at stations, refer Fig. no. PMSG-10. No fixed structure should infringe the structural gauge except for designated railway operational structures which includes platform coping, platform screen doors, hand railing in back of house platform edge, track access gates. Such designated railway operational structure should not infringe the kinematic envelope under any circumstances.
- d) For Structure Gauge at stations at Underground Stations, refer to figure no PMSG-10

- 2.2.5 For Structure Gauge at stations at Elevated Stations and At-Grade, refer to figure no PMSG-5 & PMSG-6.

2.3 TRACK GRADIENT IN PLATFORM

Gradient of track in station platform length shall be as under:

- (a) Maximum gradient 1 in 400
- (b) Desirable Level

Note: There shall be no change in gradient in platform line.

2.4 INTERLOCKING AND SIGNAL GEAR

Maximum height above rail level of any part of interlocking or signal gear on either side of centre of track subject to the restrictions embodied in Note below shall be as under:

For Underground, At-Grade and Elevated Stations

- From C.L. of track to 1330 mm 25 mm
- From 1330 mm to 1465 mm 25 mm increasing to 65 mm
- From 1465 mm to 1640 mm 65 mm increasing to 200 mm

Note:

Except for check rails on curves, ordinary and diamond crossings or wing rails and point rails of crossings leading to snag dead ends, or such parts of signalling gear as are required to be actuated by the wheels, no gear or track fittings shall project above rail level for a distance of 229 mm outside and 140 mm inside the gauge face of the rails.

2.5 POINTS & CROSSINGS

- 2.5.1 Maximum clearance of check rail opposite nose of crossing 42 mm
- 2.5.2 Minimum clearance of check rail opposite nose of crossing 40 mm
- 2.5.3 Minimum clearance between switch rail and stock rail at heel of Switch 60 mm
- 2.5.4 Maximum clearance of wing rail at nose of crossing 43 mm
- 2.5.5 Minimum clearance of wing rail at nose of crossing 41 mm
- 2.5.6 Minimum clearance between toe of open switch and stock rail 160 mm
- 2.5.7 Minimum radius of curvature for slip points, turnouts and crossovers 140 m
- 2.5.8 On main lines, the turnouts and diamond Crossings shall be of the following types

- a) 1 in 9 type turnout
 - 300 m radius
 - 190 m radius
(Exceptional circumstances)
- b) 1 in 7 type turnout
 - 190 m radius
(Desirable)
 - 140 m radius
(Exceptional circumstances)
- c) Scissors cross-over of 1 in 9 type consisting of 4 acute turnouts of 1 in 9 and 1 diamond crossing.
- d) Scissors cross-over of 1 in 7 type consisting of 4 acute turnouts of 1 in 7 and 1 diamond crossing.

2.5.9 On depot lines, non-passenger lines like pocket track, depot entry lines etc, the turnouts and diamond Crossings shall be of the following types:

a) 1 in 7 type turnout

190 m radius

140 m radius

(Exceptional circumstances)

b) Scissors cross-over of 1 in 7 type consisting of 4 acute turnouts of 1 in 7 and 1 diamond crossing.

c) 1 in 7 derailing switches/ 1 in 7 type symmetrical split turnout.

2.5.10 Diamond crossings not to be flatter than 1 in 4.444.

Note:

- a) The above restrictions shall not apply to moveable diamond crossings.
- b) Switches and crossings shall not be located on transition curves & vertical curves.
- b) There must be no change of super elevation (of outer over inner rail) between points 18 m outside toe of switch rail and nose of crossings respectively, except in the case of special crossing leading to snag dead-ends or under circumstances as provided for in item 2.6 below.

2.5.11 Minimum length of tongue rail

9000 mm

2.6 SUPER-ELEVATIONS AND SPEED AT STATIONS ON CURVES WITH TURNOUTS OF CONTRARY AND SIMILAR FLEXURE.

2.6.1 Main Line:

Subject to the permissible run through speed based on the standard of interlocking, the equilibrium super-elevation, calculated for the speed of the fastest train may be reduced by a maximum amount of 85 mm without reducing speed on the main line.

2.6.2 Turnouts:

i) Curves of contrary flexure

The equilibrium super-elevation (s) in mm should be = $(1510/127) \cdot (V^2 / R)$ Where,

R = Radius of turnout in meters and V is speed on turnout in Kmph.

The permissible negative super-elevation on the turnout (which is also the actual super-elevation of the main line) may then be = $(85 - s)$ mm.

ii) Curves of similar flexure

The question of reduction or otherwise of super-elevation on the main line must necessarily be determined by the administration concerned. In the case of a reverse curve close behind the crossing of a turnout, the super-elevation may be run out at the maximum of 1 mm in 400 mm.

2.7 ADDITIONAL CLEARANCE FOR PLATFORMS ON CURVES

The additional clearance for platforms on curves shall be provided as shown at Appendix-4

Note:

- (i) As the minimum radius of curve for stations is 1000 m, there will be no super elevation and gauge widening on passenger platform lines.

CHAPTER-III ROLLING STOCK

3.1 PASSENGER ELECTRIC MULTIPLE UNITS

3.1.1	(a) Maximum Length of the coach body (including end fairings)	21940 mm
	(b) Maximum width of the vehicle	2900 mm
	(c) Height of the coach body (maximum with pantograph in locked down condition)	4048 mm
3.1.2	Distance between bogie centers	14850± 250 mm
3.1.3	Kinematic Envelope for level tangent track	
	a. For At-Grade and Elevated Sections except for passenger platform	Figure No. PMSG-1
	b. For At-Grade and Elevated Sections at passenger platform.	Figure No. PMSG-1A
	c. For Underground sections except for passenger platform.	Figure No. PMSG-08
	d. For Underground sections at passenger platform.	PMSG-11
3.1.4	Minimum clearance above rail level under dynamic condition of fully loaded vehicle under worst condition** for bogie and axle mounted equipment.	75 mm
3.1.5	Minimum clearance above rail level under dynamic condition of fully loaded vehicle under worst condition*** for body mounted equipment.	102 mm
	**The “worst condition” means it is with deflection of primary suspension and maximum tread wear.	
	***The “worst condition” means it is with deflection of primary suspension and, deflated air spring and maximum tread wear.	
3.1.6	Wheel	
	a) Maximum wheel gauge back to back distance	1360 mm
	b) Minimum wheel gauge back to back distance	1358 mm

3.1.7	a) Maximum diameter on the tread (measured at 70 mm from wheel gauge face)	860 mm
	b) Minimum diameter on the tread (measured at 70 mm from wheel gauge face)	780 mm
3.1.8	a) Minimum projection for flange of new wheel (measured at 70 mm from wheel gauge face)	28 mm
	b) Maximum projection for flange of worn wheel (measured at 70 mm from wheel gauge face)	36 mm
3.1.9	a) Maximum thickness of flange of wheel measured from wheel gauge face at 18 mm from outer edge of flange.	32.5 mm
	b) Minimum thickness of flange of wheel measured from wheel gauge face at 18 mm from outer edge of flange.	22 mm
3.1.10	Minimum width of wheel	135±1 mm
3.1.11	Incline of tread	1 in 20
3.1.12	Floor Height	
	a) Maximum height above rail level for floor of any unloaded vehicle	1130 mm
	b) Minimum height above rail level for floor of fully loaded normal vehicle	1100 mm
3.1.13	a) Maximum height of centre coupler above rail level for unloaded vehicle	815 mm
	b) Minimum height of centre coupler above rail level for fully loaded vehicle	740 mm
3.1.14	Maximum length over couplers	22600 mm
3.1.15	Length of rigid wheel base for single bogie	2200 to 2600 mm
3.1.16	Maximum distance between any two adjacent axles	12900 mm

3.2 LOCOMOTIVES AND ENGINEERING SERVICE VEHICLES

Other items of rolling stock, viz shunting locomotives, OHE maintenance and inspection cars, emergency re-railing vans, track machines, etc., used on Pune Metro System (where these cars would be plying) will conform with the Kinematic Envelope of the Passenger Electric Multiple Units as shown in Drawing No. PMSG-1 for Elevated & At-Grade sections, Drawing No. PMSG-1A for Elevated & At-Grade sections at Platforms, Figure No. PMSG-8 for Underground sections and Figure No. PMSG-11 for Underground section at platforms.

CHAPTER-IV ELECTRIC TRACTION

(OVERHEAD ELECTRIC TRACTION 25 kV/AC 50 CYCLES PER SECOND)

Note: Special precautions must be taken to maintain following clearances:

4.1 ELECTRICAL CLEARANCES FOR AT-GRADE AND ELEVATED SECTIONS

- 4.1.1 The clearances between 25 kV live parts and earthed parts of fixed structures or moving loads shall be as large as possible. The minimum electrical clearances (vertical and horizontal) to be maintained under the worst condition of temperature, wind, etc. between any live part of the overhead equipment or pantograph and parts of any fixed structures (earthed or otherwise) or moving loads shall be below:

Vertical Clearance:

(i)	Long Duration	320 mm
(ii)	Short Duration	200 mm

Horizontal/Lateral Clearance:

(i)	Long Duration	320 mm
(ii)	Short Duration	200 mm

Note:

- (a) Long duration means when the conductor is at rest and Short Duration means when the conductor is not at rest.
- (b) A minimum vertical distance of 340 mm shall normally be provided between rolling stock and contact wire to allow for a 20 mm temporary raising of the tracks during maintenance. Wherever the allowance required for track maintenance exceeds 20 mm, the vertical distance between rolling stock and contact wire shall correspondingly be increased.
- (c) Where adoption of above clearance is either not feasible or involves abnormally high cost, a minimum vertical distance of 250 mm shall be provided between rolling stock and contact wire. At such locations, the following factors shall be maintained.
 - (i) Track to be frozen by providing permanent bench mark to indicate the level of track to be maintained.
 - (ii) Erection tolerance shall be taken as zero.
 - (iii) OHE span length shall be kept 36m or below to restrict the oscillation of contact wire.

4.1.2 Height of contact wire:

Minimum height from rail level to the underside of live Conductor wire

i)	In the open	5000 mm
ii)	Special locations (Under bridges) for locked down height of pantograph	4800 mm
iii)	In depot open area	5200 mm

- | | | |
|-----|---|---------|
| iv) | In carriage sheds and depot where the staff will likely to be working on the roof of rolling stock during the maintenance | 5500 mm |
| v) | At level crossing | 5500 mm |

Note:

- a) The normal height from rail level to the underside of contact wire is 5000 mm
- b) On curves, all vertical distances specified in items 4.1.2 above, shall be measured above level of the inner rail, increased by half the super-elevation.

4.1.3 Maximum variation of the live conductor wire on either side of the centre line of the track under static conditions:

- | | | |
|-----|-------------|--------|
| i) | On straight | +200mm |
| ii) | On Curves | +300mm |

Note:

These limits would not apply to special locations like insulated overlaps and out of run wires.

4.1.4 Maximum width of pantograph collector:

The Kinematic Envelope with the size of Pantograph adopted shall be within the Kinematic Envelope shown at Figure No. PMSG-1.

4.2 ELECTRICAL CLEARANCES FOR UNDERGROUND SECTIONS

4.2.1 Minimum height from rail level to underside of wearing copper / metal conductor of rigid OCS (Overhead contact system) in Tunnel 4318 mm

Note:-

- a) Location of exit crossing from exit point of the tunnel will take into the considerations the OHE height of 4318 mm at the tunnel exit and the permissible contact wire gradient.
- b) In the depot deck portion, if rigid OCS is provided and track is ballastless, the electrical clearances laid down at para 4.2.1 to 4.2.4 shall be applicable.
- c) For location of rigid OCS in circular tunnel with canted track, refer to Para 1.7.1 (B)-b and 1.7.2 (B)-b
- d) It shall be ensured that environment level inside the tunnel is controlled suitably so that no extra air clearance, over and above the minimum separation prescribed in Para 4.2.3 and 4.2.4 on account of pollution, fog etc., is required.

4.2.2 Stagger of rigid OCS conductor in tunnels shall not be more than

- | | | |
|------|-------------|--------|
| (i) | On Straight | +200mm |
| (ii) | On Curves | +300mm |

4.2.3 Prescribed minimum clearances between live parts of contact lines and bodies of structures

Air clearance between bodies of structures and live un-insulated body parts of contact lines, feeders and current collectors for 25KV shall be as per IEC 60913 as under:

S. No	Condition	Minimum Clearance between live parts and structures	Absolute minimum dynamic clearance between live parts and structures
(A)	Long duration (Static)	270 mm	-
(B)	Short duration (Dynamic)	170 mm	150mm*

*In exceptional cases and operating in climatic conditions (Ref: IEC 60913)

4.2.4 Prescribed minimum clearances between live parts of contact lines bodies of vehicles

Minimum air clearance between bodies of vehicles and the live un-insulated parts of the contact line or feeders for 25 kV.

S. No	Condition	Clearance (mm)
(A)	Long duration (Static)	270 mm
(B)	Short duration (Dynamic)	170 mm

4.2.5 Maximum width of pantograph - Under dynamic conditions

The kinematic envelope for underground sections in Ballastless tracks is shown in Fig. PMSG-08. The pantograph adopted should be such that its actual half KE width does not exceed 820 mm and 980 mm at the top and the bottom respectively in pantograph raised condition for a contact wire height of 4318 mm to fulfill electrical clearance as per item 4.2.3

Note:

These limits should not apply to special locations like insulated overlaps and out of run wires.

CHAPTER-V PLATFORM GATE / PLATFORM SCREEN DOORS

5.1 SETTING OUT DIMENSIONS

Minimum Platform Gate width	2000 mm
Minimum Platform Gate height	1500 mm
Minimum Platform Screen door height	1500 mm (Partial Height) 2100 mm (Full Height)
Minimum Platform Gate threshold offset from track centerline - straight track (Elevated / At-Grade)	1530 mm
Minimum Platform Gate panel offset from track centerline - straight track (Elevated / At-Grade)	1535 mm
Minimum Platform Gate header offset from track centerline (Elevated / At-Grade)	1580 mm
Minimum Platform threshold offset from track centerline - Straight track (Underground)	1515 mm
Minimum Platform screen door panel offset from track centerline - Straight track (Underground)	1589 mm

Note:

- (a) Assumed plus/minus 300 mm stopping accuracy.
- (b) Platform gate at stations on curves shall be considered separately taking into account the additional clearance as per Appendix-4.
- (c) Platform gates are designated as railway operational structures. Therefore, platform gates may infringe the Structure Gauge, but does not infringe the kinematic envelope and having minimum clearance of 10 mm from kinematic envelope to platform gate (refer PMSG-7)
- (d) The deflector attached to the bottom of the sliding door shall be designed in order not to protrude beyond the gate threshold.

Appendix-1

PERMISSIBLE SPEED, CANT AND MINIMUM TRACK SPACING ON CURVES

ELEVATED AND AT-GRADE SECTIONS

RADIUS OF CURVE	CANT	MAXIMUM PERMISSIBLE SPEED	MINIMUM DISTANCE BETWEEN ADJACENT TRACKS See note (a)
(m)	mm	kmph	mm
3000 or more	15	80	3650
2800	15	80	3650
2400	20	80	3650
2000	20	80	3650
1600	25	80	3650
1500	30	80	3650
1200	35	80	3650
1000	40	80	3700
800	55	80	3700
600	70	80	3750
500	90	80	3750
450	95	75	3750
400	105	75	3800
350	110	70	3800
300	110	65	3850
200	110	50	3950
190	110	50	3950
175	110	50	4000
150	110	45	4050
150*	0	30	4050
120	110	40	4150
120*	0	30	4150
100*	0	25	4250

UNDERGROUND (TUNNELS)

RADIUS OF CURVE	CANT	MAXIMUM PERMISSIBLE SPEED	MINIMUM DISTANCE BETWEEN ADJACENT TRACKS See note (a)
(m)	mm	kmph	mm
>3000	-	80	3500
3000	15	80	3500
2800	15	80	3500
2400	20	80	3500
2000	20	80	3500
1600	25	80	3500
1500	30	80	3510
1200	35	80	3510

1000	45	80	3550
800	55	80	3550
600	70	80	3570
500	85	80	3600
450	95	80	3610
400	105	80	3650
350	110	75	3650
300	110	70	3700
200	110	55	3800
150	110	50	4000
150*	0	30	4000
120	110	45	4000
120*	0	30	4000
100*	0	15	4000

Notes:

- The track spacing shown in the table above is without any column/structure between two tracks and is with equal cant for both outer and inner tracks.
- Track spacing shown in Table above is not applicable to stations which should be calculated depending on specific requirement but should not be less than spacing specified in para 2.1.
- Track spacing is calculated as per Para 1.8 ($E+F+T_1+T_2+300\text{mm}$ for Elevated & At-Grade sections; $E+F+T_1+T_2+200\text{mm}$ for Underground sections)
- Figures for any intermediate radius of curvature may be obtained by adopting the value for sharper curve.
- Cant provided is limited to desirable value of 110 mm.
- Maximum cant deficiency is 85 mm.
- Check rail / Restraining Rail shall be provided on curve on main line where radius is 190 m or less.

* Curves to be provided in depots.

Appendix-2
EXTRA HORIZONTAL CLEARANCE ON CURVES
(CURVATURE EFFECT)
INSIDE OF CURVE

REFERENCE: PARA 1.7.1

RADIUS OF CURVE	MID-THROW (28500/R)	NOSING INCLUDED IN K.E/ STRUCTURE GAUGE FOR TANGENT TRACK	EXTRA GAUGE TOLERANCE ON CURVES	EXTRA HORIZONTAL CLEARANCE ON CURVE	REMARKS
(m)	(mm)	(mm)	(mm)	(mm)	
(R)	(V)	(N)	(G)	(T ₁)	
100	285.0	26.0	9.0	268	(G) EXTRA GAUGE TOLERANCE ON CURVES SHARPER THAN 1000 m RADIUS: 9 mm FOR CURVES WITH RADII SHARPER THAN 500 m AND 5 mm FOR CURVES WITH RADII OF 500 m TO LESS THAN 1000 m.
120	237.5	26.0	9.0	221	
150	190.0	26.0	9.0	173	
175	162.9	26.0	9.0	146	
190*	150.0	26.0	9.0	133	
200	142.5	26.0	9.0	126	
250	114.0	26.0	9.0	97	
300	95.0	26.0	9.0	78	
350	81.4	26.0	9.0	64	
400	71.3	26.0	9.0	54	
450	63.3	26.0	9.0	46	
500	57.0	26.0	5.0	36	
600	47.5	26.0	5.0	27	
700	40.7	26.0	5.0	20	
800	35.6	26.0	5.0	15	
900	31.7	26.0	5.0	11	
1000	28.5	26.0	0.0	3	T ₁ =V-N+G for V EQUAL TO OR GREATER THAN (N) AND T ₁ = G for V < (N)
1200	23.8	26.0	0.0	0	
1500	19.0	26.0	0.0	0	
1600	17.8	26.0	0.0	0	
2000	14.3	26.0	0.0	0	
2400	11.9	26.0	0.0	0	
2800	10.2	26.0	0.0	0	
3000 or more	9.5	26.0	0.0	0	

Note:

Mid throw (in mm) $V = (125 \times C^2) / R = 28500/R$

Where 'C' is the distance between bogie centers=14.850+0.250=15.100m OR 14.85 - 0.250=14.600 m

The worst case will be with C=15.100 m

R is the radius of curve in metres.

Mid throw (in mm) $V = (125 \times C^2) / R = 28500/R$

* Check Rail / Restraining Rail shall be provided on curves on main line where radius is 190m or less.

OUTSIDE OF CURVE

REFERENCE: PARA 1.7.2

RADIUS OF CURVE	END-THROW (33525/R)	EXTRA GAUGE TOLERANCE ON CURVES	EXTRA NOSING DUE TO EXTRA GAUGE TOLERANCE	EXTRA HORIZONTAL CLEARANCE ON CURVE	REMARKS
(m)	(mm)	(mm)	(mm)	(mm)	
(R)	(Vo)	(G)	(EN)	(T ₂)	
100	335.3	9.0	2.3	347	
120	279.4	9.0	2.3	291	
150	223.5	9.0	2.3	235	
175	191.6	9.0	2.3	203	
190*	176.4	9.0	2.3	186	
200	167.6	9.0	2.3	179	
250	134.1	9.0	2.3	145	
300	111.8	9.0	2.3	123	
350	95.8	9.0	2.3	107	
400	83.8	9.0	2.3	95	
450	74.5	9.0	2.3	86	
500	67.1	5.0	1.3	73	
600	55.9	5.0	1.3	62	
700	47.9	5.0	1.3	54	
800	41.9	5.0	1.3	48	
900	37.3	5.0	1.3	44	
1000	33.5	0.0	0.0	34	
1200	27.9	0.0	0.0	28	
1500	22.4	0.0	0.0	22	
1600	21.0	0.0	0.0	21	
2000	16.8	0.0	0.0	17	
2400	14.0	0.0	0.0	14	
2800	12.0	0.0	0.0	12	
3000 or more	11.2	0.0	0.0	11	

(G) EXTRA GAUGE TOLERANCE ON CURVES SHARPER THAN 1000 m
RADIUS: 9 mm FOR CURVES WITH RADII SHARPER THAN 500 m AND 5 mm FOR CURVES WITH RADII OF 500 m TO LESS THAN 1000 m.

$T_2 = V_o + G + EN$
 $EN = G \times 0.251986301$

Note:

End Throw (in mm) $V_o = (125 \times C_1^2) / R - (125 \times C^2) / R = 33525 / R$

Where 'C' is the distance between bogie centres = 14.850+0.250=15.100m OR 14.850-.250=14.600 m

Worst case will be with C=14.600 m

'C₁' is length of coach in meters = 21.940 m and

'R' is radius of curve in meters.

* Check Rail / Restraining Rail shall be provided on curves on main line where radius is 190m or less.

APPENDIX-3

CANT EFFECT ON KINEMATIC ENVELOPE-HORIZONTAL (VEHICLE SPEED - 90 kmph)

AT-GRADE AND ELEVATED SECTIONS

REF: PARA 1.8.1

Height above rail level measured perpendicular to plane of track Distance from center line of track to K.E for tangent track.					h= 938 ab= 1582				h= 997 ab= 1584				h= 1130 ab= 1590				h= 2876 ab= 1658				h= 3296 ab= 1658				h= 4014 ab= 1225				h= 4866 ab= 1220				h= 5018 ab= 880			
Cant	Angle α degrees	Sinα	cosα	tana	E	F	H ₁	H ₂	E	F	H ₁	H ₂	E	F	H ₁	H ₂	E	F	H ₁	H ₂	E	F	H ₁	H ₂	E	F	H ₁	H ₂	E	F	H ₁	H ₂	E	F	H ₁	H ₂
110	4.178	0.073	0.997	0.073	1646	1509	1106	875	1652	1507	1165	934	1668	1503	1298	1066	1863	1444	3044	2803	1894	1413	3463	3221	1514	929	4148	3969	1571	862	4997	4819	1243	512	5124	4996
105	3.987	0.070	0.998	0.07	1643	1513	1098	878	1649	1511	1157	937	1665	1508	1290	1069	1854	1454	3037	2806	1883	1425	3456	3225	1501	943	4142	3972	1555	879	4992	4822	1227	529	5120	4997
100	3.797	0.066	0.998	0.066	1641	1516	1091	881	1647	1514	1150	940	1661	1512	1283	1072	1845	1464	3029	2810	1873	1436	3449	3229	1488	956	4136	3974	1540	895	4986	4825	1210	546	5115	4999
95	3.607	0.063	0.998	0.063	1638	1520	1083	884	1644	1518	1142	943	1658	1516	1275	1075	1836	1474	3022	2813	1862	1447	3441	3233	1475	970	4131	3976	1524	911	4981	4827	1194	563	5111	5000
90	3.417	0.060	0.998	0.06	1635	1523	1076	887	1641	1522	1135	946	1655	1520	1268	1078	1826	1484	3015	2817	1852	1459	3434	3236	1462	984	4125	3979	1508	928	4975	4830	1178	579	5107	5002
85	3.227	0.056	0.998	0.056	1632	1527	1068	890	1638	1525	1127	949	1651	1524	1260	1081	1817	1493	3007	2821	1841	1470	3427	3240	1449	997	4119	3981	1492	944	4969	4832	1161	596	5102	5003
80	3.037	0.053	0.999	0.053	1629	1530	1060	893	1635	1529	1120	952	1648	1528	1253	1084	1808	1503	3000	2824	1830	1481	3419	3244	1436	1011	4113	3983	1476	960	4964	4835	1145	613	5098	5004
75	2.847	0.050	0.999	0.05	1627	1533	1053	896	1632	1533	1112	955	1644	1532	1245	1087	1799	1513	2992	2828	1820	1492	3412	3247	1423	1024	4107	3986	1460	977	4958	4837	1128	630	5093	5006
70	2.657	0.046	0.999	0.046	1624	1537	1045	899	1629	1536	1104	957	1641	1536	1237	1090	1790	1523	2985	2831	1809	1503	3404	3251	1410	1038	4101	3988	1444	993	4952	4839	1112	646	5088	5007
65	2.467	0.043	0.999	0.043	1621	1540	1038	902	1625	1540	1097	960	1637	1540	1230	1093	1780	1533	2977	2834	1798	1515	3397	3254	1397	1051	4096	3990	1428	1009	4947	4841	1095	663	5084	5008
60	2.277	0.040	0.999	0.04	1618	1543	1030	904	1622	1543	1089	963	1634	1544	1222	1096	1771	1542	2970	2838	1788	1526	3389	3258	1384	1065	4090	3992	1412	1026	4941	4844	1079	680	5079	5009
55	2.087	0.036	0.999	0.036	1615	1547	1023	907	1619	1547	1082	966	1630	1548	1215	1099	1762	1552	2962	2841	1777	1537	3382	3261	1370	1078	4083	3994	1396	1042	4935	4846	1062	697	5074	5010
50	1.898	0.033	0.999	0.033	1612	1550	1015	910	1616	1550	1074	969	1627	1552	1207	1102	1752	1562	2954	2845	1766	1548	3374	3264	1357	1091	4077	3996	1380	1058	4929	4848	1046	713	5069	5011
45	1.708	0.030	1.000	0.03	1609	1553	1007	913	1613	1554	1066	972	1623	1556	1199	1105	1743	1572	2947	2848	1755	1559	3366	3268	1344	1105	4071	3998	1364	1074	4923	4850	1029	730	5064	5012
40	1.518	0.026	1.000	0.026	1606	1557	1000	916	1610	1557	1059	975	1619	1560	1192	1107	1734	1581	2939	2851	1745	1570	3359	3271	1331	1118	4065	4000	1348	1091	4917	4852	1013	747	5060	5013
35	1.328	0.023	1.000	0.023	1603	1560	992	919	1607	1560	1051	978	1616	1563	1184	1110	1724	1591	2931	2854	1734	1581	3351	3274	1318	1132	4059	4002	1332	1107	4910	4854	996	763	5055	5014
30	1.138	0.020	1.000	0.02	1600	1563	984	921	1603	1564	1043	980	1612	1567	1176	1113	1715	1601	2923	2857	1723	1592	3343	3277	1305	1145	4053	4004	1316	1123	4904	4856	980	780	5049	5015
25	0.949	0.017	1.000	0.017	1597	1566	977	924	1600	1567	1036	983	1608	1571	1169	1116	1705	1610	2916	2861	1712	1603	3335	3281	1291	1158	4046	4006	1300	1139	4898	4858	963	797	5044	5015
20	0.759	0.013	1.000	0.013	1594	1569	969	927	1597	1571	1028	986	1605	1575	1161	1119	1696	1620	2908	2864	1702	1614	3328	3284	1278	1172	4040	4007	1284	1155	4892	4859	946	813	5039	5016
15	0.569	0.010	1.000	0.01	1591	1573	961	930	1594	1574	1020	989	1601	1579	1153	1122	1686	1629	2900	2867	1691	1625	3320	3287	1265	1185	4033	4009	1268	1172	4885	4861	930	830	5034	5017
10	0.379	0.007	1.000	0.007	1588	1576	953	933	1591	1577	1012	991	1597	1582	1146	1124	1677	1639	2892	2870	1680	1636	3312	3290	1252	1198	4027	4011	1252	1188	4879	4863	913	847	5029	5017
5	0.190	0.003	1.000	0.003	1585	1579	946	935	1587	1581	1005	994	1594	1586	1138	1127	1668	1648	2884	2873	1669	1647	3304	3293	1238	1212	4021	4012	1236	1204	4873	4864	897	863	5023	5018
0	0.000	0.000	1.000	0	1582	1582	938	938	1584	1584	997	997	1590	1590	1130	1130	1658	1658	2876	2876	1658	1658	3296	3296	1225	1225	4014	4014	1220	1220	4866	4866	880	880	5018	5018

Refer to Figure PMSG-3

$$E=[ab+(h \times \tan \alpha)] \times \cos \alpha$$

$$F=[Ab-(h \times \tan \alpha)] \times \cos \alpha$$

$$H_1=(Ca/2)+(h / \cos \alpha)+(Ab-h \times \tan \alpha) \times \sin \alpha$$

$$H_2=(Ca/2)+(h / \cos \alpha)-(ab+h \times \tan \alpha) \times \sin \alpha$$

ab=Ab=Distance from center line of vehicle to K.E for Tangent track at height 'h' from rail level

ac=Distance from center line of canted track to K.E for Tangent track at height 'h' from rail level.

bc=hxtanα=Lateral increment due to cant(measured along the line parallel to line joining top of rails).

APPENDIX-3i

CANT EFFECT ON KINEMATIC ENVELOPE-HORIZONTAL (VEHICLE SPEED- 40 kmph)

AT-GRADE AND ELEVATED SECTIONS

REF: PARA 1.8.1

Height above rail level measured perpendicular to plane of track Distance from center line of track to K.E for tangent track.					h= 944 ab= 1516				h= 1066 ab= 1516				h= 1133 ab= 1516				h= 2874 ab= 1581				h= 3296 ab= 1580				h= 4014 ab= 1225				h= 4866 ab= 1220				h= 5018 ab= 880			
Cant	Angle α degrees	Sina	cosa	tana	E	F	H ₁	H ₂	E	F	H ₁	H ₂	E	F	H ₁	H ₂	E	F	H ₁	H ₂	E	F	H ₁	H ₂	E	F	H ₁	H ₂	E	F	H ₁	H ₂	E	F	H ₁	H ₂
110	4.178	0.073	0.997	0.073	1581	1443	1107	886	1590	1434	1229	1008	1595	1429	1295	1075	1786	1367	3037	2806	1816	1336	3457	3227	1514	929	4148	3969	1571	862	4997	4819	1243	512	5124	4996
105	3.987	0.070	0.998	0.07	1578	1447	1100	889	1586	1438	1221	1011	1591	1434	1288	1077	1777	1377	3029	2810	1805	1347	3450	3231	1501	943	4142	3972	1555	879	4992	4822	1227	529	5120	4997
100	3.797	0.066	0.998	0.066	1575	1450	1092	892	1583	1442	1214	1013	1588	1438	1281	1080	1768	1387	3022	2813	1795	1358	3443	3234	1488	956	4136	3974	1540	895	4986	4825	1210	546	5115	4999
95	3.607	0.063	0.998	0.063	1572	1454	1085	894	1580	1446	1207	1016	1584	1442	1274	1083	1759	1397	3015	2816	1784	1370	3436	3238	1475	970	4131	3976	1524	911	4981	4827	1194	563	5111	5000
90	3.417	0.060	0.998	0.06	1570	1457	1078	897	1577	1450	1199	1019	1581	1446	1266	1086	1749	1407	3008	2820	1774	1381	3429	3241	1462	984	4125	3979	1508	928	4975	4830	1178	579	5107	5002
85	3.227	0.056	0.998	0.056	1567	1460	1070	900	1574	1454	1192	1021	1577	1450	1259	1088	1740	1417	3001	2823	1763	1392	3422	3244	1449	997	4119	3981	1492	944	4969	4832	1161	596	5102	5003
80	3.037	0.053	0.999	0.053	1564	1464	1063	902	1570	1457	1185	1024	1574	1454	1252	1091	1731	1427	2994	2826	1752	1403	3415	3248	1436	1011	4113	3983	1476	960	4964	4835	1145	613	5098	5004
75	2.847	0.050	0.999	0.05	1561	1467	1056	905	1567	1461	1177	1027	1570	1458	1244	1094	1722	1436	2986	2829	1742	1414	3408	3251	1423	1024	4107	3986	1460	977	4958	4837	1128	630	5093	5006
70	2.657	0.046	0.999	0.046	1558	1471	1048	908	1564	1465	1170	1030	1567	1462	1237	1097	1713	1446	2979	2833	1731	1426	3401	3254	1410	1038	4101	3988	1444	993	4952	4839	1112	646	5088	5007
65	2.467	0.043	0.999	0.043	1555	1474	1041	910	1560	1469	1163	1032	1563	1466	1230	1099	1703	1456	2972	2836	1720	1437	3393	3257	1397	1051	4096	3990	1428	1009	4947	4841	1095	663	5084	5008
60	2.277	0.040	0.999	0.04	1552	1477	1033	913	1557	1472	1155	1035	1560	1470	1222	1102	1694	1466	2965	2839	1710	1448	3386	3261	1384	1065	4090	3992	1412	1026	4941	4844	1079	680	5079	5009
55	2.087	0.036	0.999	0.036	1549	1481	1026	916	1554	1476	1148	1038	1556	1474	1215	1105	1685	1475	2957	2842	1699	1459	3379	3264	1370	1078	4083	3994	1396	1042	4935	4846	1062	697	5074	5010
50	1.898	0.033	0.999	0.033	1546	1484	1019	918	1550	1480	1141	1040	1553	1478	1208	1107	1675	1485	2950	2845	1688	1470	3372	3267	1357	1091	4077	3996	1380	1058	4929	4848	1046	713	5069	5011
45	1.708	0.030	1.000	0.03	1543	1487	1011	921	1547	1484	1133	1043	1549	1482	1200	1110	1666	1495	2942	2848	1678	1481	3364	3270	1344	1105	4071	3998	1364	1074	4923	4850	1029	730	5064	5012
40	1.518	0.026	1.000	0.026	1540	1490	1004	924	1544	1487	1126	1045	1545	1485	1193	1112	1657	1504	2935	2851	1667	1492	3357	3273	1331	1118	4065	4000	1348	1091	4917	4852	1013	747	5060	5013
35	1.328	0.023	1.000	0.023	1537	1494	996	926	1540	1491	1118	1048	1542	1489	1185	1115	1647	1514	2927	2854	1656	1503	3349	3276	1318	1132	4059	4002	1332	1107	4910	4854	996	763	5055	5014
30	1.138	0.020	1.000	0.02	1534	1497	989	929	1537	1495	1111	1051	1538	1493	1178	1118	1638	1524	2920	2857	1645	1514	3342	3279	1305	1145	4053	4004	1316	1123	4904	4856	980	780	5049	5015
25	0.949	0.017	1.000	0.017	1531	1500	981	931	1533	1498	1103	1053	1535	1497	1170	1120	1628	1533	2912	2860	1634	1525	3334	3282	1291	1158	4046	4006	1300	1139	4898	4858	963	797	5044	5015
20	0.759	0.013	1.000	0.013	1528	1503	974	934	1530	1502	1096	1056	1531	1501	1163	1123	1619	1543	2905	2863	1624	1536	3327	3285	1278	1172	4040	4007	1284	1155	4892	4859	946	813	5039	5016
15	0.569	0.010	1.000	0.01	1525	1507	967	936	1527	1505	1089	1058	1527	1505	1156	1125	1609	1552	2897	2866	1613	1547	3319	3288	1265	1185	4033	4009	1268	1172	4885	4861	930	830	5034	5017
10	0.379	0.007	1.000	0.007	1522	1510	959	939	1523	1509	1081	1061	1523	1508	1148	1128	1600	1562	2889	2868	1602	1558	3311	3290	1252	1198	4027	4011	1252	1188	4879	4863	913	847	5029	5017
5	0.190	0.003	1.000	0.003	1519	1513	952	941	1520	1512	1074	1063	1520	1512	1141	1130	1591	1571	2882	2871	1591	1569	3304	3293	1238	1212	4021	4012	1236	1204	4873	4864	897	863	5023	5018
0	0.000	0.000	1.000	0	1516	1516	944	944	1516	1516	1066	1066	1516	1516	1133	1133	1581	1581	2874	2874	1580	1580	3296	3296	1225	1225	4014	4014	1220	1220	4866	4866	880	880	5018	5018

Refer to Figure PMSG-3

$$E=[ab+(h \times \tan \alpha)] \times \cos \alpha$$

$$F=[Ab-(h \times \tan \alpha)] \times \cos \alpha$$

$$H_1=(Ca/2)+(h / \cos \alpha)+(Ab-h \times \tan \alpha) \times \sin \alpha$$

$$H_2=(Ca/2)+(h / \cos \alpha)-(ab+h \times \tan \alpha) \times \sin \alpha$$

ab=Ab=Distance from center line of vehicle to K.E for Tangent track at height 'h' from rail level

ac=Distance from center line of canted track to K.E for Tangent track at height 'h' from rail level.

bc=hxtanα=Lateral increment due to cant(measured along the line parallel to line joining top of rails).

APPENDIX-3A

**CANT EFFECT ON STRUCTURE GAUGE (CORRESPONDING TO 90 kmph KE)-HORIZONTAL
AT-GRADE AND ELEVATED SECTIONS
REFERENCE: PARA 1.8.2**

ALL FIGURES ARE IN mm

Height above rail level measured perpendicular to plane of track Distance from center line of track to Structure Gauge for tangent track.					h= 305 ab= 1640				h= 930 ab= 1735				h= 3310 ab= 1825				h= 3775 ab= 1546				h= 6200 ab= 1546			
Cant	Angle α degrees	Sinα	cosα	tanα	E ₁	F ₁	H ₁	H ₂	E ₁	F ₁	H ₁	H ₂	E ₁	F ₁	H ₁	H ₂	E ₁	F ₁	H ₁	H ₂	E ₁	F ₁	H ₁	H ₂
110	4.178	0.073	0.997	0.07	1658	1613	479	240	1798	1663	1109	856	2061	1579	3489	3223	1817	1267	3933	3707	1994	1090	6351	6126
105	3.987	0.070	0.998	0.07	1657	1615	471	243	1795	1666	1101	860	2051	1590	3481	3228	1805	1280	3926	3711	1973	1111	6345	6130
100	3.797	0.066	0.998	0.07	1657	1616	463	246	1793	1670	1093	863	2040	1602	3474	3232	1793	1293	3919	3714	1953	1132	6339	6134
95	3.607	0.063	0.998	0.06	1656	1618	455	249	1790	1673	1085	867	2030	1613	3466	3236	1780	1305	3912	3718	1933	1153	6332	6138
90	3.417	0.060	0.998	0.06	1655	1619	447	252	1787	1676	1077	870	2019	1624	3458	3240	1768	1318	3905	3721	1913	1174	6326	6142
85	3.227	0.056	0.998	0.06	1655	1620	439	255	1785	1680	1069	873	2008	1636	3450	3245	1756	1331	3899	3724	1893	1195	6320	6146
80	3.037	0.053	0.999	0.05	1654	1622	431	258	1782	1683	1061	877	1998	1647	3442	3249	1744	1344	3892	3728	1872	1215	6313	6149
75	2.847	0.050	0.999	0.05	1653	1623	424	261	1779	1687	1053	880	1987	1658	3434	3253	1732	1357	3885	3731	1852	1236	6307	6153
70	2.657	0.046	0.999	0.05	1652	1624	416	264	1776	1690	1044	884	1976	1670	3426	3257	1719	1369	3878	3734	1832	1257	6300	6157
65	2.467	0.043	0.999	0.04	1652	1625	408	267	1773	1693	1036	887	1966	1681	3418	3261	1707	1382	3871	3737	1811	1278	6293	6160
60	2.277	0.040	0.999	0.04	1651	1627	400	270	1771	1697	1028	890	1955	1692	3410	3265	1695	1395	3863	3741	1791	1298	6287	6164
55	2.087	0.036	0.999	0.04	1650	1628	392	273	1768	1700	1020	894	1944	1703	3402	3269	1682	1407	3856	3744	1771	1319	6280	6167
50	1.898	0.033	0.999	0.03	1649	1629	384	276	1765	1703	1012	897	1934	1714	3394	3273	1670	1420	3849	3747	1750	1340	6273	6170
45	1.708	0.030	1.000	0.03	1648	1630	376	278	1762	1707	1004	900	1923	1726	3385	3277	1658	1433	3842	3750	1730	1361	6266	6174
40	1.518	0.026	1.000	0.03	1648	1631	368	281	1759	1710	996	904	1912	1737	3377	3280	1645	1445	3835	3753	1710	1381	6259	6177
35	1.328	0.023	1.000	0.02	1647	1632	360	284	1756	1713	987	907	1901	1748	3369	3284	1633	1458	3827	3756	1689	1402	6252	6180
30	1.138	0.020	1.000	0.02	1646	1634	353	287	1753	1716	979	910	1890	1759	3361	3288	1621	1471	3820	3759	1669	1423	6244	6183
25	0.949	0.017	1.000	0.02	1645	1635	345	290	1750	1719	971	914	1880	1770	3352	3292	1608	1483	3813	3761	1648	1443	6237	6186
20	0.759	0.013	1.000	0.01	1644	1636	337	293	1747	1723	963	917	1869	1781	3344	3296	1596	1496	3805	3764	1628	1464	6230	6189
15	0.569	0.010	1.000	0.01	1643	1637	329	296	1744	1726	955	920	1858	1792	3335	3299	1583	1508	3798	3767	1608	1484	6223	6192
10	0.379	0.007	1.000	0.01	1642	1638	321	299	1741	1729	946	923	1847	1803	3327	3303	1571	1521	3790	3770	1587	1505	6215	6195
5	0.190	0.003	1.000	0	1641	1639	313	302	1738	1732	938	927	1836	1814	3319	3306	1558	1533	3783	3772	1567	1525	6208	6197
0	0.000	0.000	1.000	0	1640	1640	305	305	1735	1735	930	930	1825	1825	3310	3310	1546	1546	3775	3775	1546	1546	6200	6200

Refer to Figure PMSG-3A

$$E_1 = [ab + (h \times \tan \alpha)] \times \cos \alpha$$

$$F_1 = [ab - (h \times \tan \alpha)] \times \cos \alpha$$

$$H_1 = (Ca/2) + (h / \cos \alpha) + (Ab - h \times \tan \alpha) \times \sin \alpha$$

$$H_2 = (Ca/2) + (h / \cos \alpha) - (ab + h \times \tan \alpha) \times \sin \alpha$$

ab=Ab=Distance from center line of vehicle to Structure gauge for Tangent track at height 'h' from rail level

ac=Distance from center line of canted track to Structure Gauge for Tangent track at height 'h' from rail level.

bc=hxtanα=Lateral increment due to cant (measured along the line parallel to line joining top of rails).

APPENDIX-3Ai

CANT EFFECT ON STRUCTURE GAUGE (CORRESPONDING TO 40 kmph KE)-HORIZONTAL
AT-GRADE AND ELEVATED SECTIONS

ALL FIGURES ARE IN mm

Height above rail level measured perpendicular to plane of track Distance from center line of track to Structure Gauge for tangent track.					h= 305 ab= 1569				h= 1133 ab= 1666				h= 932 ab= 1666				h= 3310 ab= 1730				h= 3775 ab= 1545				h= 6200 ab= 1545			
Cant	Angle α degrees	Sinα	cosα	tanα	E ₁	F ₁	H ₁	H ₂	E ₁	F ₁	H ₁	H ₂	E ₁	F ₁	H ₁	H ₂	E ₁	F ₁	H ₁	H ₂	E ₁	F ₁	H ₁	H ₂	E ₁	F ₁	H ₁	H ₂
110	4.178	0.073	0.997	0.07	1587	1543	473	245	1744	1579	1306	1064	1729	1594	1106	863	1967	1484	3482	3230	1816	1266	3933	3707	1993	1089	6351	6126
105	3.987	0.070	0.998	0.07	1586	1544	466	248	1741	1583	1299	1067	1727	1597	1098	866	1956	1496	3475	3234	1804	1279	3926	3711	1972	1110	6345	6130
100	3.797	0.066	0.998	0.07	1586	1545	458	250	1737	1587	1291	1070	1724	1601	1090	870	1945	1507	3467	3238	1792	1292	3919	3714	1952	1131	6339	6134
95	3.607	0.063	0.998	0.06	1585	1547	451	253	1734	1591	1283	1073	1721	1604	1082	873	1935	1518	3460	3242	1779	1304	3912	3718	1932	1152	6332	6138
90	3.417	0.060	0.998	0.06	1584	1548	443	256	1731	1596	1275	1077	1719	1607	1075	876	1924	1530	3452	3246	1767	1317	3905	3721	1912	1173	6326	6142
85	3.227	0.056	0.998	0.06	1584	1549	435	259	1727	1600	1267	1080	1716	1611	1067	879	1914	1541	3445	3250	1755	1330	3898	3725	1892	1194	6320	6146
80	3.037	0.053	0.999	0.05	1583	1551	428	261	1724	1604	1260	1083	1713	1614	1059	882	1903	1552	3437	3254	1743	1343	3892	3728	1871	1214	6313	6149
75	2.847	0.050	0.999	0.05	1582	1552	420	264	1720	1608	1252	1086	1710	1618	1051	886	1892	1563	3429	3257	1731	1356	3885	3731	1851	1235	6307	6153
70	2.657	0.046	0.999	0.05	1581	1553	412	267	1717	1612	1244	1090	1707	1621	1043	889	1882	1575	3422	3261	1718	1368	3878	3734	1831	1256	6300	6157
65	2.467	0.043	0.999	0.04	1581	1554	405	270	1713	1616	1236	1093	1705	1624	1035	892	1871	1586	3414	3265	1706	1381	3871	3737	1810	1277	6293	6160
60	2.277	0.040	0.999	0.04	1580	1556	397	272	1710	1620	1228	1096	1702	1628	1027	895	1860	1597	3406	3269	1694	1394	3863	3741	1790	1297	6286	6164
55	2.087	0.036	0.999	0.04	1579	1557	389	275	1706	1624	1220	1099	1699	1631	1020	898	1849	1608	3398	3272	1681	1406	3856	3744	1770	1318	6280	6167
50	1.898	0.033	0.999	0.03	1578	1558	382	278	1703	1628	1213	1102	1696	1634	1012	901	1839	1619	3390	3276	1669	1419	3849	3747	1749	1339	6273	6170
45	1.708	0.030	1.000	0.03	1577	1559	374	281	1699	1631	1205	1105	1693	1637	1004	904	1828	1631	3383	3279	1657	1432	3842	3750	1729	1360	6266	6174
40	1.518	0.026	1.000	0.03	1577	1560	366	283	1695	1635	1197	1108	1690	1641	996	908	1817	1642	3375	3283	1644	1444	3835	3753	1709	1380	6259	6177
35	1.328	0.023	1.000	0.02	1576	1562	359	286	1692	1639	1189	1112	1687	1644	988	911	1806	1653	3367	3287	1632	1457	3827	3756	1688	1401	6252	6180
30	1.138	0.020	1.000	0.02	1575	1563	351	289	1688	1643	1181	1115	1684	1647	980	914	1795	1664	3359	3290	1620	1470	3820	3759	1668	1422	6244	6183
25	0.949	0.017	1.000	0.02	1574	1564	343	291	1685	1647	1173	1118	1681	1650	972	917	1785	1675	3351	3293	1607	1482	3813	3761	1647	1442	6237	6186
20	0.759	0.013	1.000	0.01	1573	1565	336	294	1681	1651	1165	1121	1678	1654	964	920	1774	1686	3343	3297	1595	1495	3805	3764	1627	1463	6230	6189
15	0.569	0.010	1.000	0.01	1572	1566	328	297	1677	1655	1157	1124	1675	1657	956	923	1763	1697	3335	3300	1582	1507	3798	3767	1607	1483	6223	6192
10	0.379	0.007	1.000	0.01	1571	1567	320	300	1673	1658	1149	1127	1672	1660	948	926	1752	1708	3326	3303	1570	1520	3790	3770	1586	1504	6215	6195
5	0.190	0.003	1.000	0	1570	1568	313	302	1670	1662	1141	1130	1669	1663	940	929	1741	1719	3318	3307	1557	1532	3783	3772	1566	1524	6208	6197
0	0.000	0.000	1.000	0	1569	1569	305	305	1666	1666	1133	1133	1666	1666	932	932	1730	1730	3310	3310	1545	1545	3775	3775	1545	1545	6200	6200

Refer to Figure PMSG-3A

$$E_1 = [ab + (h \times \tan \alpha)] \times \cos \alpha$$

$$F_1 = [ab - (h \times \tan \alpha)] \times \cos \alpha$$

$$H_1 = (Ca/2) + (h / \cos \alpha) + (ab - h \times \tan \alpha) \times \sin \alpha$$

$$H_2 = (Ca/2) + (h / \cos \alpha) - (ab + h \times \tan \alpha) \times \sin \alpha$$

ab=Ab=Distance from center line of vehicle to Structure gauge for Tangent track at height 'h' from rail level

ac=Distance from center line of canted track to Structure Gauge for Tangent track at height 'h' from rail level.

bc=hxtanα=Lateral increment due to cant (measured along the line parallel to line joining top of rails).

APPENDIX 3 : CANT EFFECT ON STRUCTURAL GAUGE– HORIZONTAL (VEHICLE SPEED 90 KMPH)

APPENDIX - 3 (UG) (Pune Metro)
CANT EFFECT ON STRUCTURAL GAUGE - HORIZONTAL
UNDER GROUND SECTIONS (CIRCULAR TUNNELS)

All Figures are in mm

Cant	Alpha Degree	Alpha Radians	Sin Alpha	Cos Alpha	Tan Alpha	h= 305		ab= 1585		h= 940		ab= 1670		h= 1095		ab= 1675		h= 3305		ab= 1740		h= 3965		ab= 1250		h= 4838		ab= 1250	
						E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2
110	4.1776	0.0729	0.0728	0.9973	0.0730	1603	1559	475	244	1734	1597	1114	871	1750	1591	1269	1025	1976	1495	3478	3224	1536	958	4101	3918	1599	894	4971	4789
105	3.9874	0.0696	0.0695	0.9976	0.0697	1602	1560	467	247	1731	1601	1106	874	1747	1595	1261	1028	1966	1506	3470	3229	1523	971	4095	3921	1583	911	4966	4792
100	3.7972	0.0663	0.0662	0.9978	0.0664	1602	1561	459	249	1729	1604	1099	877	1744	1599	1254	1032	1955	1517	3463	3233	1510	985	4089	3924	1568	927	4960	4795
95	3.6071	0.0630	0.0629	0.9980	0.0630	1601	1563	452	252	1726	1608	1091	881	1741	1603	1246	1035	1944	1529	3455	3236	1497	998	4083	3926	1552	943	4955	4797
90	3.4170	0.0596	0.0596	0.9982	0.0597	1600	1564	444	255	1723	1611	1083	884	1737	1607	1238	1038	1934	1540	3448	3240	1484	1011	4077	3928	1536	959	4949	4800
85	3.2270	0.0563	0.0563	0.9984	0.0564	1600	1565	436	258	1720	1614	1075	887	1734	1611	1230	1041	1923	1551	3440	3244	1471	1025	4072	3931	1520	976	4943	4802
80	3.0370	0.0530	0.0530	0.9986	0.0531	1599	1567	429	261	1717	1618	1067	890	1731	1615	1222	1045	1913	1562	3433	3248	1458	1038	4066	3933	1505	992	4937	4805
75	2.8470	0.0497	0.0497	0.9988	0.0497	1598	1568	421	263	1715	1621	1059	893	1727	1619	1214	1048	1902	1574	3425	3252	1445	1052	4060	3936	1489	1008	4932	4807
70	2.6570	0.0464	0.0464	0.9989	0.0464	1597	1569	413	266	1712	1625	1051	897	1724	1622	1206	1051	1891	1585	3417	3256	1432	1065	4054	3938	1473	1024	4926	4810
65	2.4671	0.0431	0.0430	0.9991	0.0431	1597	1570	405	269	1709	1628	1044	900	1721	1626	1199	1054	1881	1596	3409	3260	1420	1078	4048	3940	1457	1041	4920	4812
55	2.0874	0.0364	0.0364	0.9993	0.0364	1595	1573	390	275	1703	1635	1028	906	1714	1634	1183	1061	1859	1618	3394	3267	1394	1105	4035	3944	1425	1073	4908	4817
45	1.7077	0.0298	0.0298	0.9996	0.0298	1593	1575	375	280	1697	1641	1012	912	1707	1642	1167	1067	1838	1641	3378	3274	1368	1131	4023	3948	1394	1105	4896	4821
40	1.5179	0.0265	0.0265	0.9996	0.0265	1593	1576	367	283	1694	1645	1004	915	1703	1645	1159	1070	1827	1652	3370	3278	1355	1145	4017	3950	1378	1121	4889	4823
35	1.3282	0.0232	0.0232	0.9997	0.0232	1592	1578	359	286	1691	1648	996	919	1700	1649	1151	1073	1816	1663	3362	3281	1342	1158	4010	3952	1362	1138	4883	4825
30	1.1384	0.0199	0.0199	0.9998	0.0199	1591	1579	351	288	1688	1651	988	922	1696	1653	1143	1077	1805	1674	3354	3285	1329	1171	4004	3954	1346	1154	4877	4827
25	0.9486	0.0166	0.0166	0.9999	0.0166	1590	1580	344	291	1685	1654	980	925	1693	1657	1135	1080	1794	1685	3346	3288	1315	1184	3998	3956	1330	1170	4871	4829
20	0.7589	0.0132	0.0132	0.9999	0.0132	1589	1581	336	294	1682	1657	972	928	1689	1660	1127	1083	1784	1696	3338	3292	1302	1197	3991	3958	1314	1186	4864	4831
15	0.5692	0.0099	0.0099	1.0000	0.0099	1588	1582	328	297	1679	1661	964	931	1686	1664	1119	1086	1773	1707	3330	3295	1289	1211	3985	3960	1298	1202	4858	4833
10	0.3794	0.0066	0.0066	1.0000	0.0066	1587	1583	320	299	1676	1664	956	934	1682	1668	1111	1089	1762	1718	3321	3298	1276	1224	3978	3962	1282	1218	4851	4835
5	0.1897	0.0033	0.0033	1.0000	0.0033	1586	1584	313	302	1673	1667	948	937	1679	1671	1103	1092	1751	1729	3313	3302	1263	1237	3972	3963	1266	1234	4845	4836
0	0.0000	0.0000	0.0000	1.0000	0.0000	1585	1585	305	305	1670	1670	940	940	1675	1675	1095	1095	1740	1740	3305	3305	1250	1250	3965	3965	1250	1250	4838	4838

Where:

g= 1510 Rail centre to centre distance

h= Height above rail level measured perpendicular to plane of track.

 $E1 = [ab + (h \times \tan \alpha)] \times \cos \alpha$ $F1 = [ab - (h \times \tan \alpha)] \times \cos \alpha$ $H1 = (Ca / 2) + (h / \cos \alpha) + (Ab - h \times \tan \alpha) \times \sin \alpha$ $H2 = (Ca / 2) + (h / \cos \alpha) - (ab + h \times \tan \alpha) \times \sin \alpha$

ab=Ab Distance from center line of vehicle to Kinematic Envelope for

Refer Figure No. PMSG-3A

APPENDIX - 4

**ADDITIONAL CLEARANCES FOR PLATFORMS ON CURVES
FOR ELEVATED, AT-GRADE AND UNDERGROUND SECTIONS**

Radius of Horizontal Curve (m)	Extra Clearance (mm)												
	Inside of Curve								Outside of Curve				
	At Center line of Boggies				At edge of open door nearest to C.L. of Boggies				At end of coach	At edge of open door nearest to C.L. of Boggies			
	Mid Throw (V) = $28500/R$	Nosing (N)	Additional Clearance (V-N)	Additional Clearance Rounded Off to upper 5mm	Throw (V3) = $28498/R$	Nosing (N1) = $13 \times 0.873 / 10.97$	Additional Clearance (V3-(N-N1))	Additional Clearance Rounded Off to upper 5mm	End Throw (V4) = $33525/R$	Throw (V5) = $19340/R$	Nosing (N2) = $13 \times 9.59 / 10.97$	Additional Clearance (V5-(N-N2))	Additional Clearance Rounded Off to upper 5mm
3000	10	13	-4	0	9	1	-2	0	11	6	11	5	5
2800	10	13	-3	0	10	1	-2	0	12	7	11	5	5
1800	16	13	3	0	16	1	4	0	19	11	11	9	0
2400	12	13	-1	0	12	1	0	0	14	8	11	6	10
2000	14	13	1	5	14	1	2	5	17	10	11	8	10
1800	16	13	3	5	16	1	4	5	19	11	11	9	10
1600	18	13	5	5	18	1	6	10	21	12	11	10	10
1500	19	13	6	10	19	1	7	10	22	13	11	11	15
1200	24	13	11	15	24	1	12	15	28	16	11	14	15
1000	29	13	16	20	28	1	17	20	34	19	11	18	20

Notes:-

1. For outside of curve, the difference between clearance required at coach end that at the farthest door edge is less than 25mm. As half width of coach at ends is atleast 25mm less than that at door locations, additional clearance to be provided is additional clearance required at the farthest door edge.

2. Values of additional clearances are rounded off to next 5mm.

3. Extra clearance for curves:

Mid throw (in mm) $V = (125 \times C^2) / R = 28500/R$

Where 'C' is the distance between bogie centers = $14.850 + 0.250 = 15.100\text{m}$ or $14.85 - 0.25 = 14.600\text{m}$

The worst case will be with $C = 15.100\text{ m}$

R is the radius of curve in metres.

$V3 = \{ \{125\} \times (15.1^2 - 4 \times 0.873^2) / R \} = 28498/R$

$N1 = N \times (X) / (C1/2) = 13 \times 0.873 / 10.97$

Minimum distance 'X' for the nearest edge of an open door from the center line of Boggies is 0.8

End Throw (in mm) $Vo = (125 \times C_1^2) / R - (125 \times C^2) / R = 33525.45/R$

Where 'C' is the distance between bogie centers = $14.850 + 0.250 = 15.100\text{m}$ OR $14.850 - 0.250 = 14.600\text{m}$.

Worst case will be with $C = 14.600$

'C₁' is length of coach in meters = 21.94 m and 'R' is radius of curve in meters.

$V4 = \{ \{125\} \times (19.18^2 - 14.6^2) / R \} = 19340/R$ for farthest edge of end door in open position

with $C1 = 2 \times 9.590 = 19.18$ meters and $C = 14.60$ metres for the worst case

$N2 = N \times (X) / (C1/2) = 13 \times 9.59 / 10.97$

4. There will be no superelevation on curves in platform portion

APPENDIX 4 (UG): CANT EFFECT ON KINEMATIC ENVELOPE- HORIZONTAL

APPENDIX - 4 (UG) (Pune Metro)

CANT EFFECT ON KINEMATIC ENVELOPE

UNDER GROUND SECTIONS (CIRCULAR TUNNEL)

																		All Figures are in mm															
Cant	Alpha Degree	Alpha Radians	Sin Alpha	Cos Alpha	Tan Alpha	h= 947		ab= 1570		h= 1130		ab= 1576		h= 2885		ab= 1629		h= 4005		ab= 1089		h= 4158		ab= 980		h= 4318		ab= 820					
						E	F	H1	H2	E	F	H1	H2	E	F	H1		E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2
110	4.1776	0.0729	0.0728	0.9973	0.0730	1635	1497	1114	885	1654	1489	1297	1067	1835	1415	3051	2814	1378	794	4129	3970	1280	674	4273	4131	1132	503	4421	4302				
105	3.9874	0.0696	0.0695	0.9976	0.0697	1632	1500	1106	888	1651	1494	1289	1070	1826	1424	3044	2817	1365	808	4124	3972	1267	688	4269	4132	1118	518	4417	4303				
100	3.7972	0.0663	0.0662	0.9978	0.0664	1629	1504	1099	891	1647	1498	1282	1073	1816	1434	3037	2821	1352	821	4118	3974	1253	702	4264	4134	1104	532	4413	4304				
95	3.6071	0.0630	0.0629	0.9980	0.0630	1626	1507	1091	894	1644	1502	1274	1076	1807	1444	3029	2824	1339	835	4113	3976	1240	716	4259	4136	1090	547	4409	4305				
90	3.4170	0.0596	0.0596	0.9982	0.0597	1624	1511	1084	897	1641	1506	1267	1079	1798	1454	3022	2828	1326	848	4108	3978	1226	730	4254	4137	1076	561	4404	4306				
85	3.2270	0.0563	0.0563	0.9984	0.0564	1621	1514	1076	900	1637	1510	1259	1082	1789	1464	3015	2831	1313	862	4102	3980	1213	744	4249	4139	1062	576	4400	4307				
80	3.0370	0.0530	0.0530	0.9986	0.0531	1618	1518	1069	902	1634	1514	1252	1085	1780	1474	3007	2835	1300	875	4097	3982	1199	758	4244	4140	1048	590	4395	4308				
75	2.8470	0.0497	0.0497	0.9988	0.0497	1615	1521	1061	905	1630	1518	1244	1088	1770	1484	3000	2838	1287	889	4092	3983	1185	772	4239	4142	1033	605	4391	4309				
70	2.6570	0.0464	0.0464	0.9989	0.0464	1612	1524	1054	908	1627	1522	1237	1091	1761	1494	2992	2841	1273	902	4086	3985	1172	786	4234	4143	1019	619	4386	4310				
65	2.4671	0.0431	0.0430	0.9991	0.0431	1609	1528	1046	911	1623	1526	1229	1094	1752	1503	2985	2845	1260	916	4081	3987	1158	800	4229	4144	1005	633	4382	4311				
55	2.0874	0.0364	0.0364	0.9993	0.0364	1603	1534	1031	917	1616	1534	1214	1099	1733	1523	2970	2851	1234	942	4070	3990	1131	828	4218	4147	977	662	4373	4313				
45	1.7077	0.0298	0.0298	0.9996	0.0298	1598	1541	1016	922	1609	1542	1199	1105	1714	1542	2955	2858	1208	969	4058	3993	1103	856	4208	4149	948	691	4363	4314				
40	1.5179	0.0265	0.0265	0.9996	0.0265	1595	1544	1008	925	1605	1546	1191	1108	1705	1552	2947	2861	1195	983	4052	3995	1090	870	4203	4151	934	705	4358	4315				
35	1.3282	0.0232	0.0232	0.9997	0.0232	1592	1548	1001	928	1602	1549	1184	1111	1695	1562	2939	2864	1182	996	4047	3996	1076	883	4197	4152	920	720	4353	4315				
30	1.1384	0.0199	0.0199	0.9998	0.0199	1589	1551	993	931	1598	1553	1176	1113	1686	1571	2932	2867	1168	1009	4041	3998	1062	897	4192	4153	906	734	4348	4316				
25	0.9486	0.0166	0.0166	0.9999	0.0166	1585	1554	985	933	1594	1557	1168	1116	1677	1581	2924	2870	1155	1023	4035	3999	1049	911	4186	4154	891	748	4343	4316				
20	0.7589	0.0132	0.0132	0.9999	0.0132	1582	1557	978	936	1591	1561	1161	1119	1667	1591	2916	2873	1142	1036	4029	4000	1035	925	4181	4155	877	763	4338	4317				
15	0.5692	0.0099	0.0099	1.0000	0.0099	1579	1561	970	939	1587	1565	1153	1122	1658	1600	2909	2876	1129	1049	4023	4001	1021	939	4175	4156	863	777	4333	4317				
10	0.3794	0.0066	0.0066	1.0000	0.0066	1576	1564	962	942	1583	1568	1145	1125	1648	1610	2901	2879	1115	1062	4017	4003	1008	952	4169	4156	849	791	4328	4317				
5	0.1897	0.0033	0.0033	1.0000	0.0033	1573	1567	955	944	1580	1572	1138	1127	1639	1619	2893	2882	1102	1076	4011	4004	994	966	4164	4157	834	806	4323	4318				
0	0.0000	0.0000	0.0000	1.0000	0.0000	1570	1570	947	947	1576	1576	1130	1130	1629	1629	2885	2885	1089	1089	4005	4005	980	980	4158	4158	820	820	4318	4318				

Where:

g= 1510 Rail centre to centre distance

h= Height above rail level measured perpendicular to plane of track.

 $E = [ab + (h \times \tan \alpha)] \times \cos \alpha$ $F = [ab - (h \times \tan \alpha)] \times \cos \alpha$ $H1 = (Ca / 2) + (h / \cos \alpha) + (ab - h \times \tan \alpha) \times \sin \alpha$ $H2 = (Ca / 2) + (h / \cos \alpha) - (ab + h \times \tan \alpha) \times \sin \alpha$ Distance from center line of vehicle to Kinematic Envelope for
ab=Ab : Tangent track at height "h" from rail level.

Refer Figure No. PMSG-3

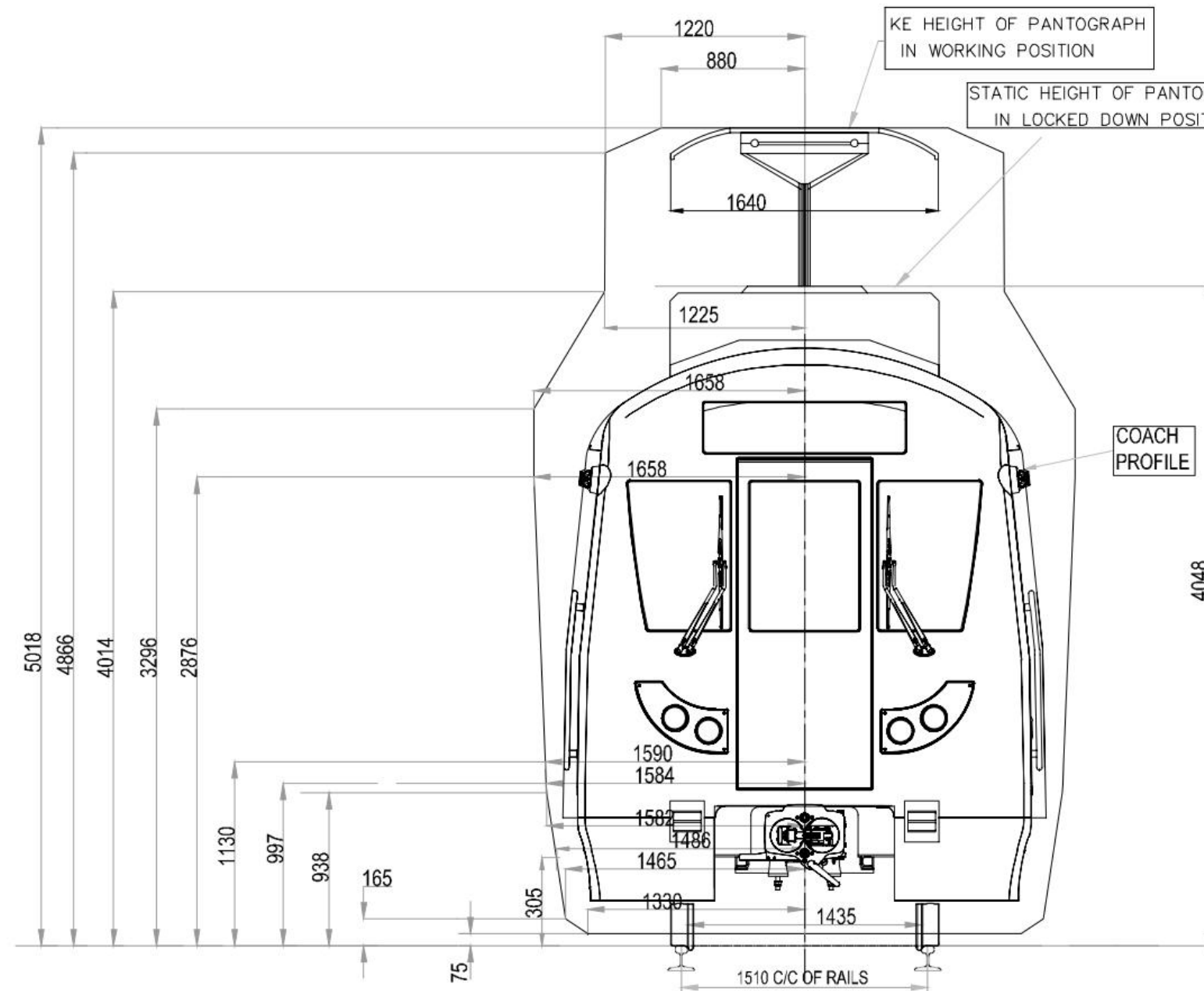
APPENDIX - 5

LATERAL AND VERTICAL SHIFT OF CENTER OF CIRCULAR TUNNEL FOR DIFFERENT CANT VALUES

(WITH D1 = 730mm)

Cant	$\sin \alpha = \text{Cant}/1510$	Angle α	$\tan \theta = (r - D1)/(g/2)$	Angle θ	Lateral Shift of Tunnel Center=X	Lateral Shift of Tunnel Center=Y	REMARKS
mm		Degree		Degrees	mm	mm	
110	0.0728	4.1776	2.8742	70.8159	160	49	<p>(a) The cant is provided by raising the outer rail which will mean, rotating the tunnel about the mid point of top of inner rail.</p> <p>(b) 'X' is lateral shift of the center of the tunnel towards inside of the curve $X = \left[\frac{2x(r-D1)}{\sin(\theta)} \right] \times \left\{ \sin\left(\frac{\alpha}{2}\right) \right\} \times \cos(90-\theta-\alpha/2)$</p> <p>(c) 'Y' is the vertical shift of the center of the tunnel (upwards) $Y = \left[\frac{2x(r-D1)}{\sin(\theta)} \right] \times \left\{ \sin\left(\frac{\alpha}{2}\right) \right\} \times \sin(90-\theta-\alpha/2)$ where, 'r' is internal radius of the circular tunnel = 2900mm 'D1' = depth from rail level to invert of circular tunnel = 730mm α = angle of rotation $\sin(\alpha) = (\text{Cant}/g)$ θ = angle subtended by line joining top of two rails and the line joining mid point of top of inner rail and the center of circular tunnel $\tan(\theta) = [(r-D1)/(g/2)]$ which gives $\theta = 70.8159$ degrees g = Center to center of rails = 1510mm</p>
105	0.0695	3.9874	2.8742	70.8159	153	47	
100	0.0662	3.7972	2.8742	70.8159	145	45	
95	0.0629	3.6071	2.8742	70.8159	138	43	
90	0.0596	3.4170	2.8742	70.8159	131	41	
85	0.0563	3.2270	2.8742	70.8159	123	39	
80	0.0530	3.0370	2.8742	70.8159	116	37	
75	0.0497	2.8470	2.8742	70.8159	109	35	
70	0.0464	2.6570	2.8742	70.8159	101	33	
65	0.0430	2.4671	2.8742	70.8159	94	30	
60	0.0397	2.2773	2.8742	70.8159	87	28	
55	0.0364	2.0874	2.8742	70.8159	80	26	
50	0.0331	1.8976	2.8742	70.8159	72	24	
45	0.0298	1.7077	2.8742	70.8159	65	22	
40	0.0265	1.5179	2.8742	70.8159	58	19	
35	0.0232	1.3282	2.8742	70.8159	51	17	
30	0.0199	1.1384	2.8742	70.8159	43	15	
25	0.0166	0.9486	2.8742	70.8159	36	12	
20	0.0132	0.7589	2.8742	70.8159	29	10	
15	0.0099	0.5692	2.8742	70.8159	22	7	
10	0.0066	0.3794	2.8742	70.8159	14	5	
5	0.0033	0.1897	2.8742	70.8159	7	2	
0	0.0000	0.0000	2.8742	70.8159	0	0	

Refer Figure No. PMSG-12



NOTES

1. ALL DIMENSIONS ARE IN mm
2. HORIZONTAL AND VERTICAL CLEARANCES DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA
3. KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION
4. THE CONDUCTOR HEIGHT ABOVE RAIL LEVEL SHALL ALSO TAKE IN TO CONSIDERATION PRESCRIBED ELECTRICAL CLEARANCES BETWEEN ALL LIVE OVERHEAD EQUIPMENT AND PANTOGRAPH / VEHICLE AND ALL PARTS THEREOF.
5. A TYPE OR ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR A DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE OF THE GAUGE FACE OF THE WHEEL.
6. KINEMATICS ENVELOPE FOR 90 kmph VEHICLE SPEED AND SIDE WIND SPEED OF 100 kmph.

**KINEMATIC ENVELOPE FOR 90 kmph
AT-GRADE AND ELEVATED SECTIONS
ON LEVEL OR CONSTANT GRADE TANGENT TRACK
EXCEPT FOR PASSENGER PLATFORM**

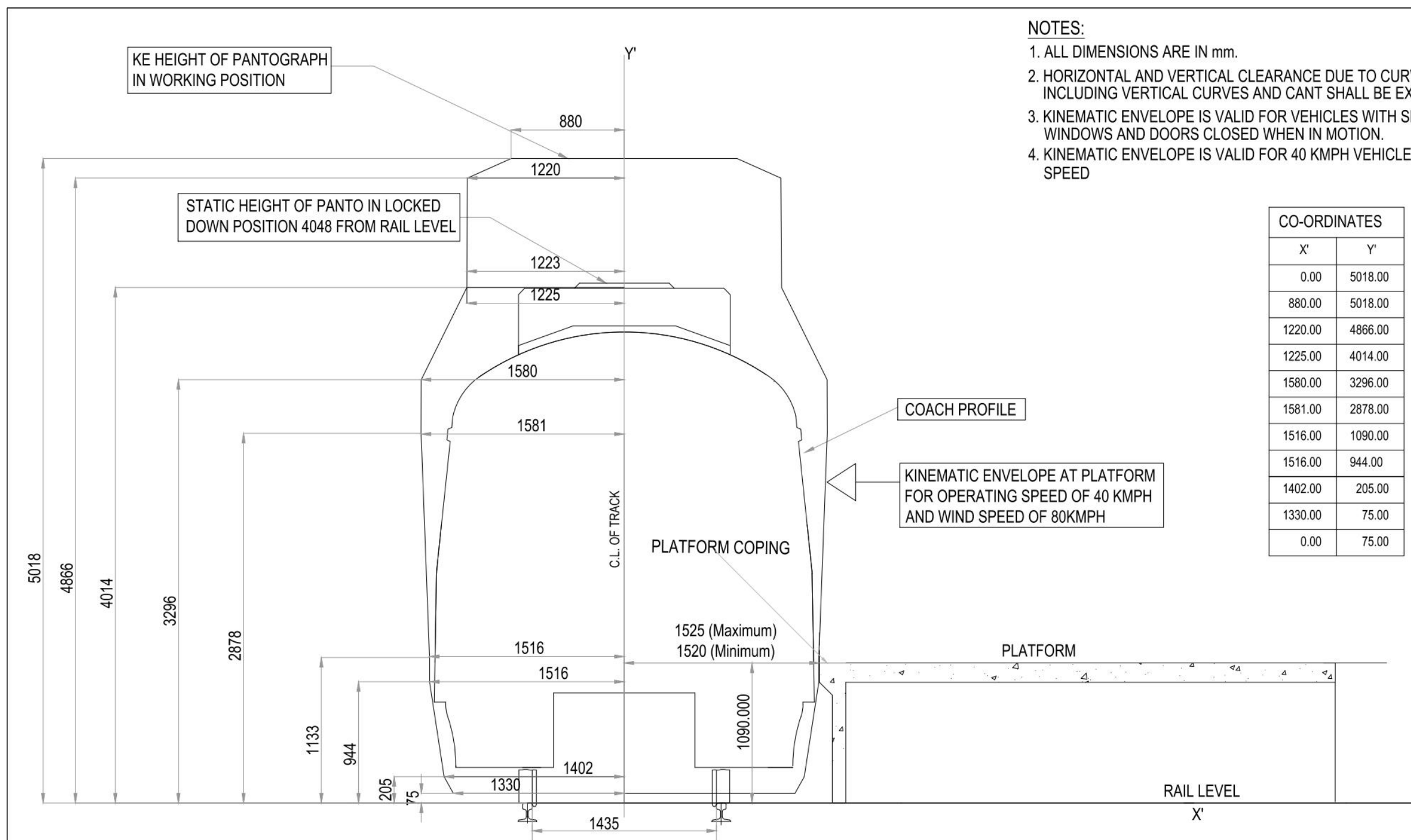
FIGURE No. PMSG-1

SCALE: NOT TO SCALE REF: PARA 1.5, 3.1, 3.2 & 4.1.4



PUNE METRO RAIL PROJECT
MAHARASHTRA METRO RAIL
CORPORATION LIMITED

STANDARD GAUGE
(1435 mm)
25 kV A.C. TRACTION



PUNE METRO RAIL PROJECT
MAHARASHTRA METRO RAIL CORPORATION LIMITED

STANDARD GAUGE
 (1435 mm)

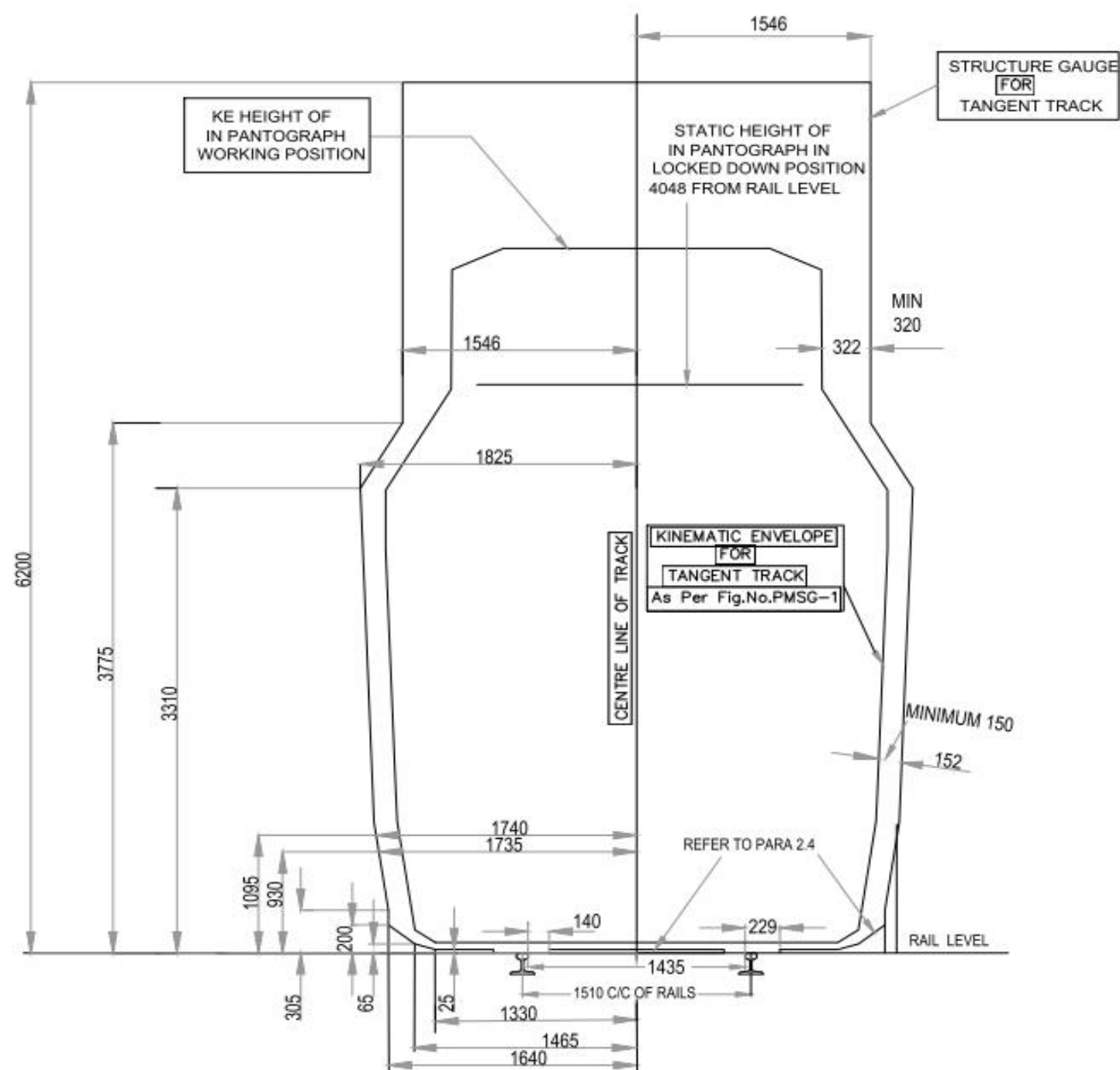
25 kV A.C. TRACTION

KINEMATIC ENVELOPE FOR 40 KMPH
 AT GRADE AND ELEVATED SECTIONS
 ON LEVEL OR CONSTANT GRADE TANGENT TRACK
 AT PASSENGER PLATFORM

FIGURE NO. PMSG-1A

SCALE: NOT TO SCALE

REF: PARA 1.5, 3.1 & 3.2



NOTES

1. ALL DIMENSIONS ARE IN mm.
2. THIS STRUCTURE GAUGE WILL ALSO BE APPLICABLE FOR ROB_s/FOB_s AT STATIONS WITHOUT THE MAST UNDER THE STRUCTURES. IN CASE THE CONTACT WIRE IS HIGHER, THE HEIGHT OF THE ROB/FOB SHALL BE INCREASED ACCORDINGLY.
3. MINIMUM CLERANCE BETWEEN KINEMATIC ENVELOPE AND STRUCTURE GAUGE WILL BE 150 mm. MINIMUM ELECTRICAL CLEARANCE OF 320 mm SHALL BE MAINTAINED BETWEEN 25 KV LIVE PARTS AND THE EARTHED STRUCTURES.
4. MINIMUM LATERAL CLEARANCE FOR OHE MAST WILL BE 2150 mm FROM THE CENTRE OF TRACK.
5. MINIMUM LATERAL CLEARANCE FOR OHE MAST WILL BE 1950 mm FROM THE CENTRE OF TRACK FOR AT GRADE AND DEPOT.
6. THE KINEMATIC ENVELOPE AND STRUCTURE GAUGE ARE VALID FOR ROLLING STOCK WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
7. HORIZONTAL AND VERTICAL CLEARANCE DUE TO CURVES INCLUDING VERTICAL CURVE AND CANT SHALL BE EXTRA.
8. FOR KINEMATIC ENVELOPE, REFER TO FIGURE:PMSG-1
9. THIS STRUCTURE GAUGE IS VALID FOR 90 kmph VEHICLE SPEED

STRUCTURE GAUGE
AT-GRADE AND ELEVATED SECTIONS
(OUTSIDE STATION)
 ON
 LEVEL OR CONSTANT GRADE TANGENT TRACK

FIGURE No. PMSG-2

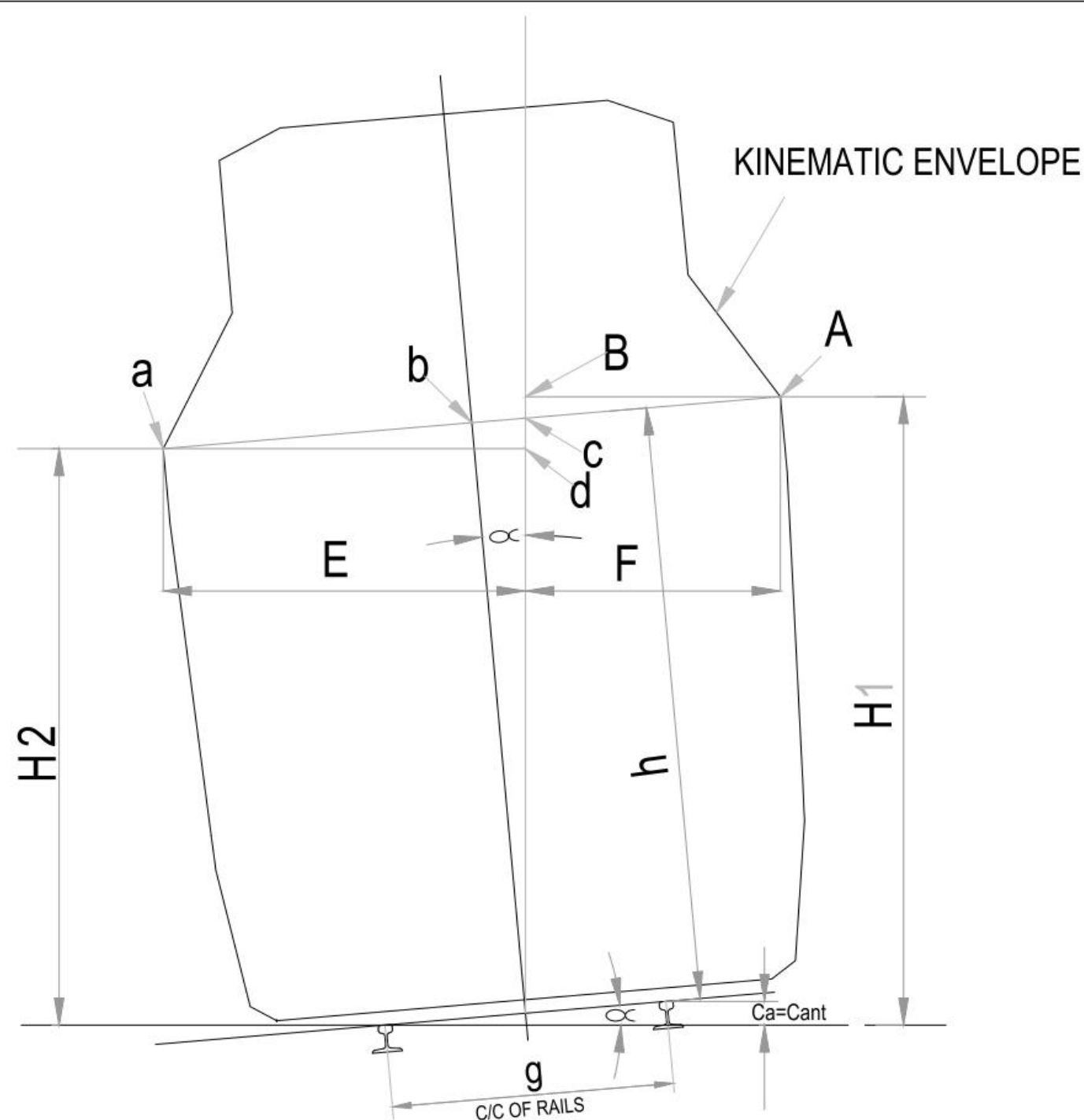
SCALE: NOT TO SCALE

REF: PARA 1.4 & 1.6



PUNE METRO RAIL PROJECT
MAHARASHTRA METRO RAIL
CORPORATION LIMITED

STANDARD GAUGE
 (1435 mm)
25 kV A.C.TRACTION



$ab=Ab$ = Distance from centerline of track to Kinematic Envelope for Tangent Track at height 'h'

$\sin \alpha = \text{cant}/g$

$g = 1510 \text{ mm}$

Ca = Cant applied

$E = [ab + (h \times \tan \alpha)] \times \cos \alpha$

$F = [Ab - (h \times \tan \alpha)] \times \cos \alpha$

$H_1 = (Ca/2) + (h/\cos \alpha) + (Ab - h \times \tan \alpha) \times \sin \alpha$

$H_2 = (Ca/2) + (h/\cos \alpha) - (ab + h \times \tan \alpha) \times \sin \alpha$

For values of E , F , H_1 and H_2 , refer to Appendix 3 for 90 kmph Kinematic Envelope and Appendix 3i for 40 kmph Kinematic Envelope.

NOTES:

KINEMATIC ENVELOPE FOR AT-GRADE/ELEVATED SECTIONS HAS BEEN SHOWN AS A TYPICAL FIGURE.

THE FORMULAE FOR E, F, H_1 AND H_2 SHOWN IN THIS FIGURE WILL ALSO APPLY TO UNDERGROUND BOX TUNNELS

EFFECT OF CANT ON KINEMATIC ENVELOPE

FIGURE No. PMSG-3

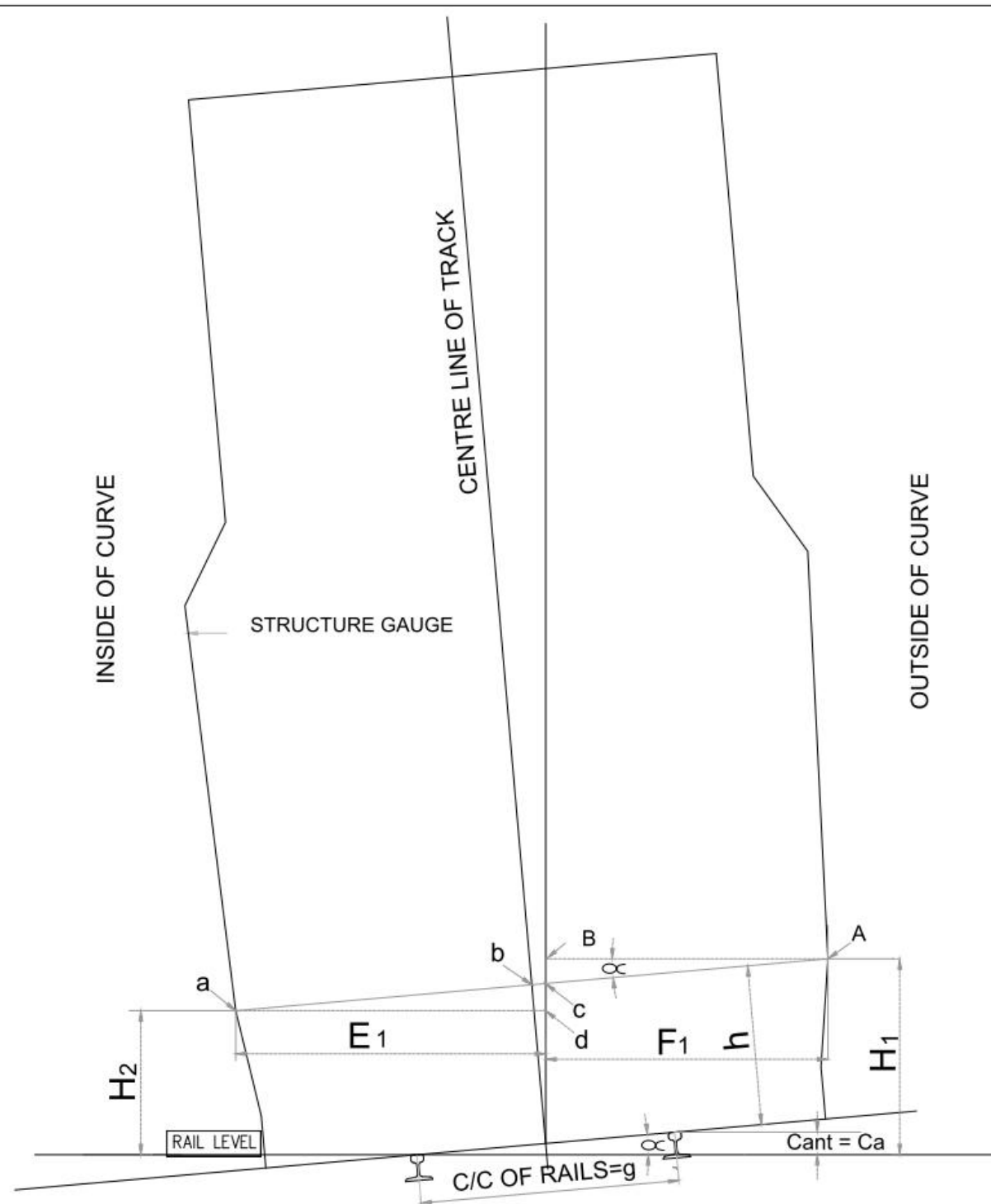
SCALE: NOT TO SCALE

REF: PARA 1.8.1



PUNE METRO RAIL PROJECT
MAHARASHTRA METRO RAIL CORPORATION LIMITED

STANDARD GAUGE
(1435 mm)
25 kV A.C. TRACTION



$ab=Ab=$ Distance from centerline of track to Structure Gauge for Tangent Track at height 'h'

$$\sin \alpha = \text{cant}/g$$

$$g = 1510 \text{ mm}$$

$Ca =$ Cant applied

$$E_1 = [ab + (h \times \tan \alpha)] \times \cos \alpha$$

$$F_1 = [Ab - (h \times \tan \alpha)] \times \cos \alpha$$

$$H_1 = (Ca/2) + (h/\cos \alpha) + (Ab - h \times \tan \alpha) \times \sin \alpha$$

$$H_2 = (Ca/2) + (h/\cos \alpha) - (ab + h \times \tan \alpha) \times \sin \alpha$$

For values of E_1 , F_1 , H_1 and H_2 , refer to

Appendix 3A for 90 kmph Kinematic Envelope and

Appendix 3Ai for 40 kmph Kinematic Envelope.

NOTES:

STRUCTURE GAUGE FOR AT-GRADE/ELEVATED SECTION HAS BEEN SHOWN AS A TYPICAL FIGURE.

THE FORMULAE FOR E, F, H_1 AND H_2 SHOWN IN THIS FIGURE WILL ALSO APPLY TO UNDERGROUND BOX TUNNELS

THE STRUCTURE GAUGE IS VALID FOR A MAXIMUM SPEED OF 95 KMPH AND OPERATING SPEED OF 90 KMPH

EFFECT OF CANT ON STRUCTURE GAUGE

FIGURE No. PMSG-3A

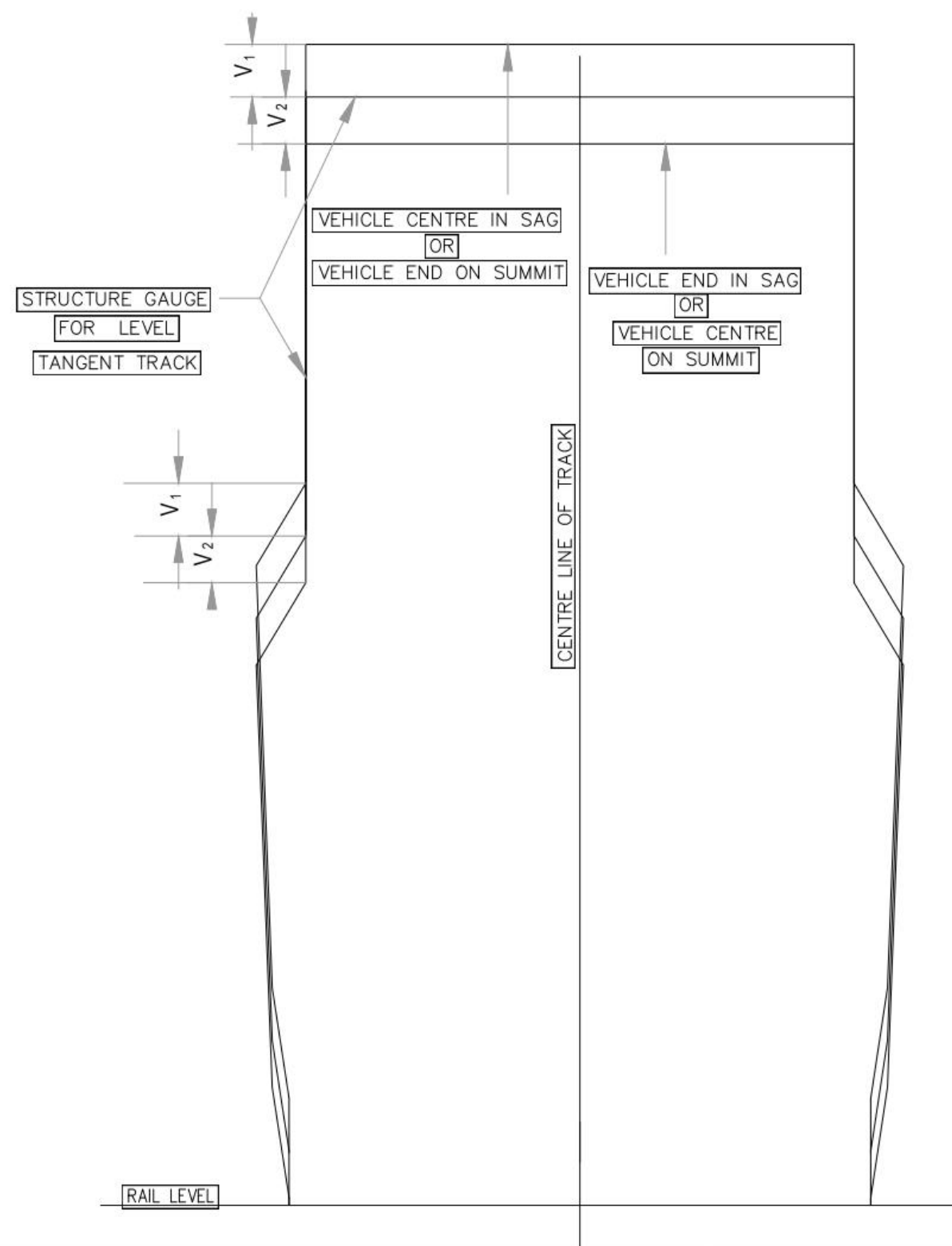
SCALE: NOT TO SCALE

REF: PARA 1.7.1,
1.7.2 & 1.8.2



PUNE METRO RAIL PROJECT
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STANDARD GAUGE
(1435 mm)
25 kV A.C. TRACTION



VERTICAL THROW:

RADIUS OF VERTICAL CURVE metres	V ₁ mm	V ₂ mm
1500	19	22
1600	18	21
1700	17	20
1800	16	19
1900	15	18
2000	14	17
2100	14	16
2200	13	15
2300	12	15
2400	12	14
2500	11	14
2600	11	13
2700	11	12
2800	10	12
2900	10	12
3000	10	11

NOTE:

THE FIGURE IS TYPICAL AND WILL APPLY TO ELEVATED, UNDERGROUND AND AT-GRADE SECTIONS.

EFFECT OF VERTICAL CURVE ON STRUCTURE GAUGE

FIGURE No. PMSG-4

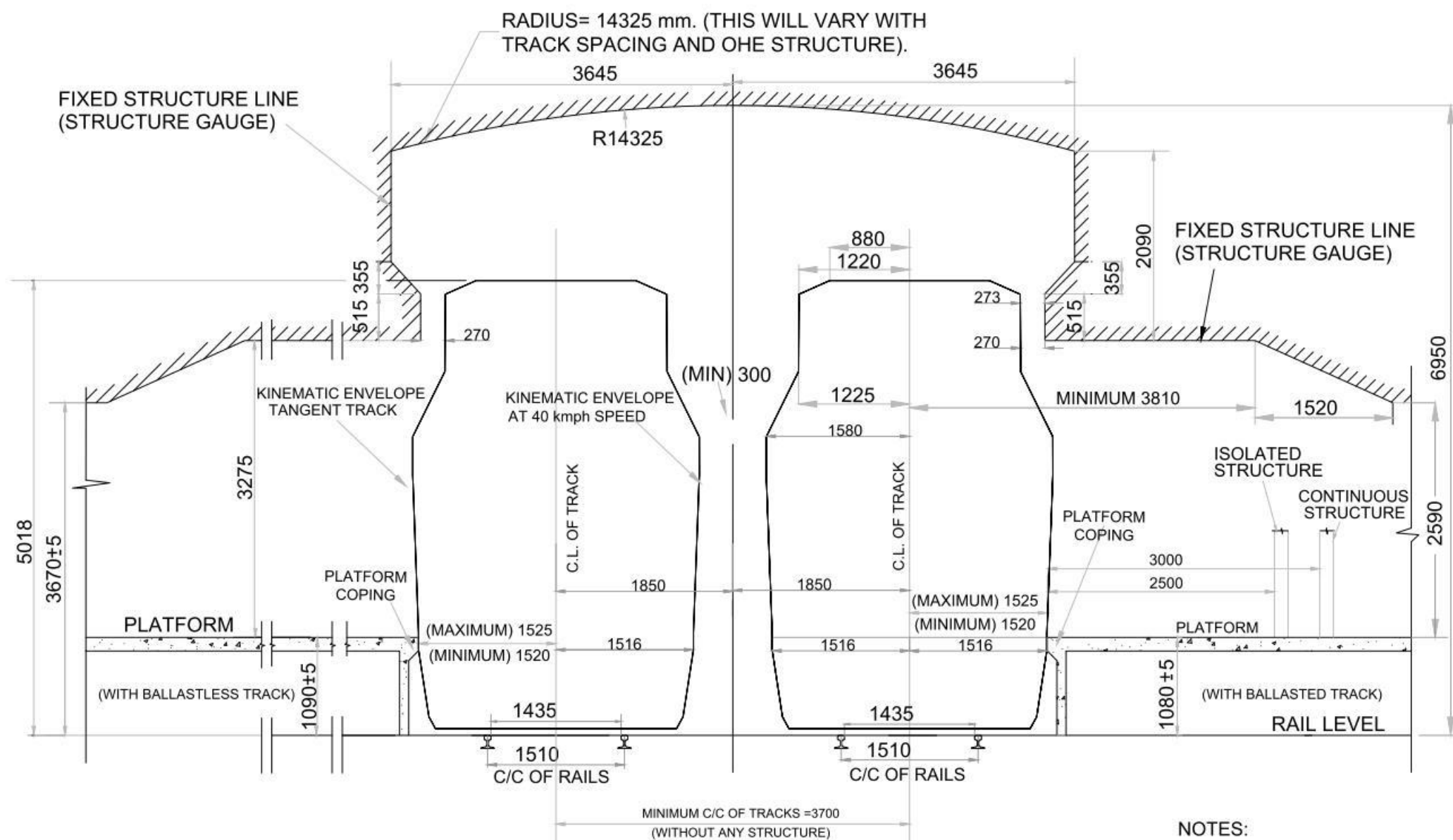
SCALE: NOT TO SCALE

REF: PARA 1.7.1(C) & 1.7.2(C)



PUNE METRO RAIL PROJECT
MAHARASHTRA METRO RAIL CORPORATION LIMITED

STANDARD GAUGE
 (1435 mm)
25 kV A.C. TRACTION



NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. CLEARANCE FOR CURVE/CANT SHALL BE EXTRA. HOWEVER THE TRACK CENTRES AT STATION WILL NOT INCREASE WITH CURVES OF RADIUS OF 1000 M AND ABOVE.
3. STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION
4. OHE IS SUSPENDED FROM CEILING BY DROP ARM.



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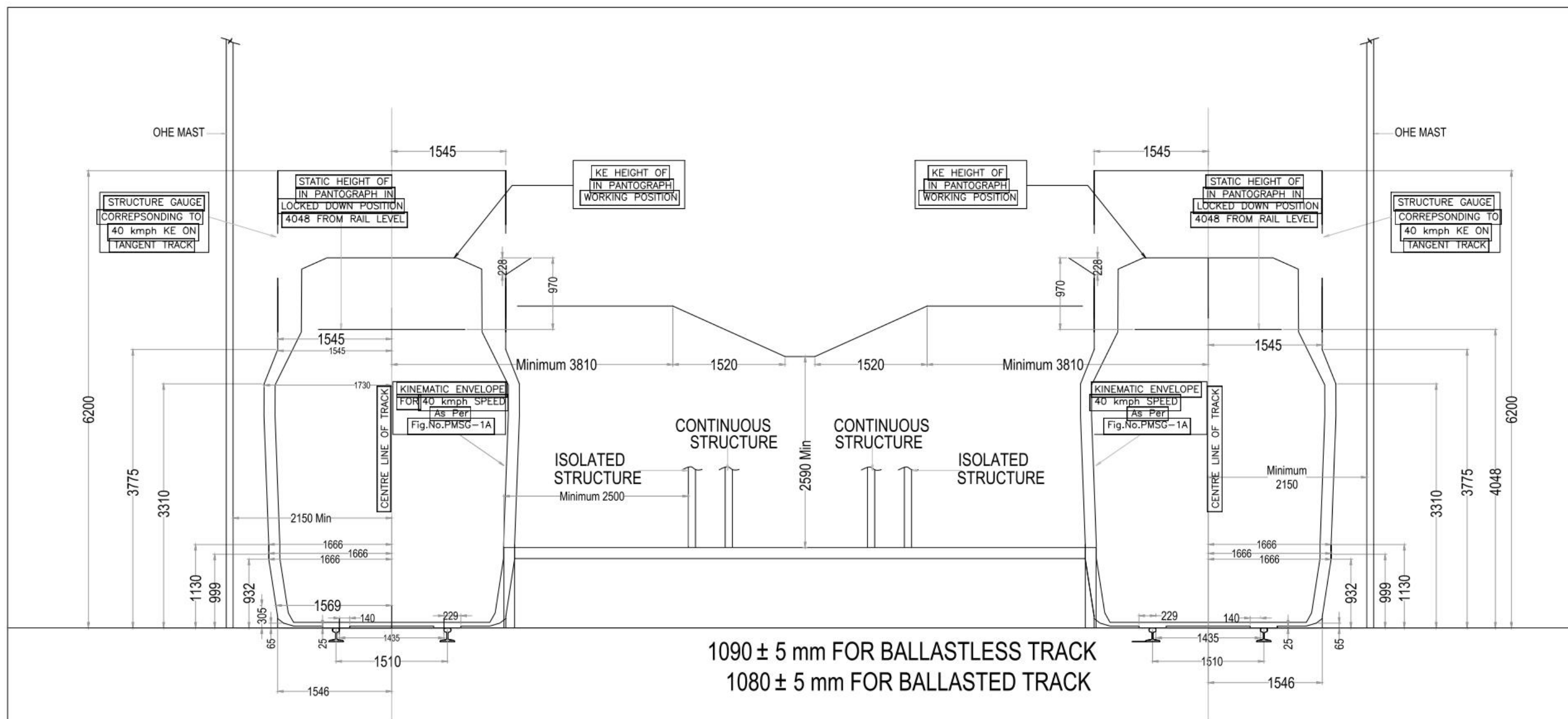
STANDARD GAUGE
 (1435 mm)
 25 kV A.C. TRACTION

**STRUCTURE GAUGE AT
 ELEVATED/AT-GRADE STATION
 WITH SIDE PLATFORMS
 LEVEL OR CONSTANT GRADE TANGENT TRACK**

FIGURE NO. PMSG-5

SCALE: NOT TO SCALE

REF: PARA 2.2.4



TYPICAL FOR 8.0 m WIDE ISLAND PLATFORM.

NOTES :

- All Dimensions are in mm.
- Clearance for curve shall be extra.
- Structure gauge is valid for vehicles with sealed windows and doors closed while in motion.
- Distance of platform coping from center of track as per the Para-2.2



PUNE METRO RAIL PROJECT
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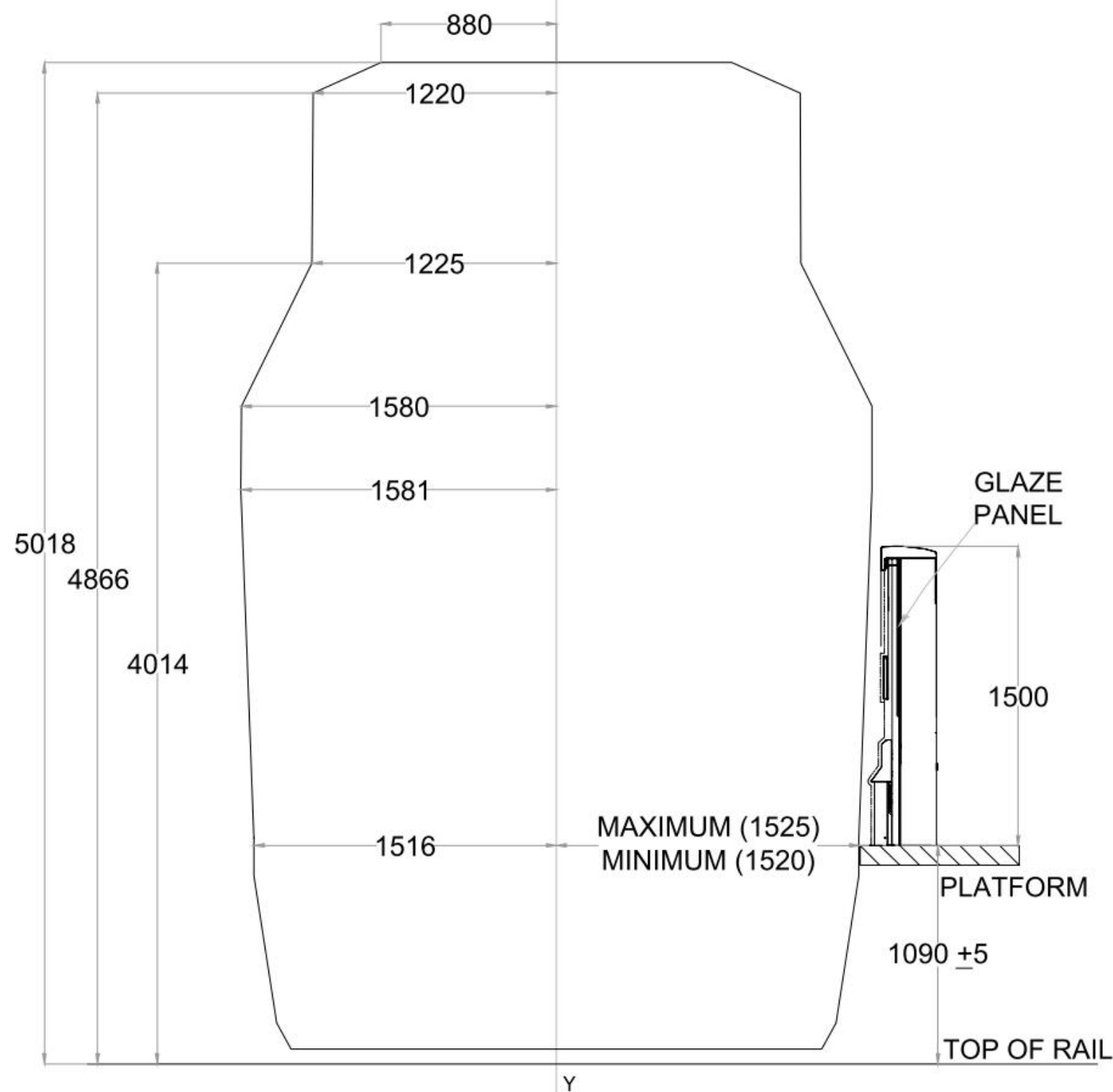
STANDARD GAUGE
 (1435mm)
 25 kV A.C. TRACTION

STRUCTURE GAUGE AT ELEVATED STATION
 WITH ISLAND PLATFORM
 ON LEVEL OR CONSTANT GRADE TANGENT TRACK

FIGURE NO PMSG - 6

SCALE: NOT TO SCALE

REFER PARA 2.2.4



NOTES:

1. ALL DIMENSION ARE IN mm.
2. HORIZONTAL CLEARANCES DUE TO CURVES SHALL BE EXTRA
3. KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHEN IN MOTION.
4. MINIMUM GAP OF 10 mm SHALL BE MAINTAINED BETWEEN KE AND PLATFORM GATE AT ANY POINT.

PLATFORM GATE ELEVATED/AT GRADE
(PLATFORM) ON LEVEL OR CONSTANT
GRADE TANGENT TRACK

FIGURE No. PMSG - 7

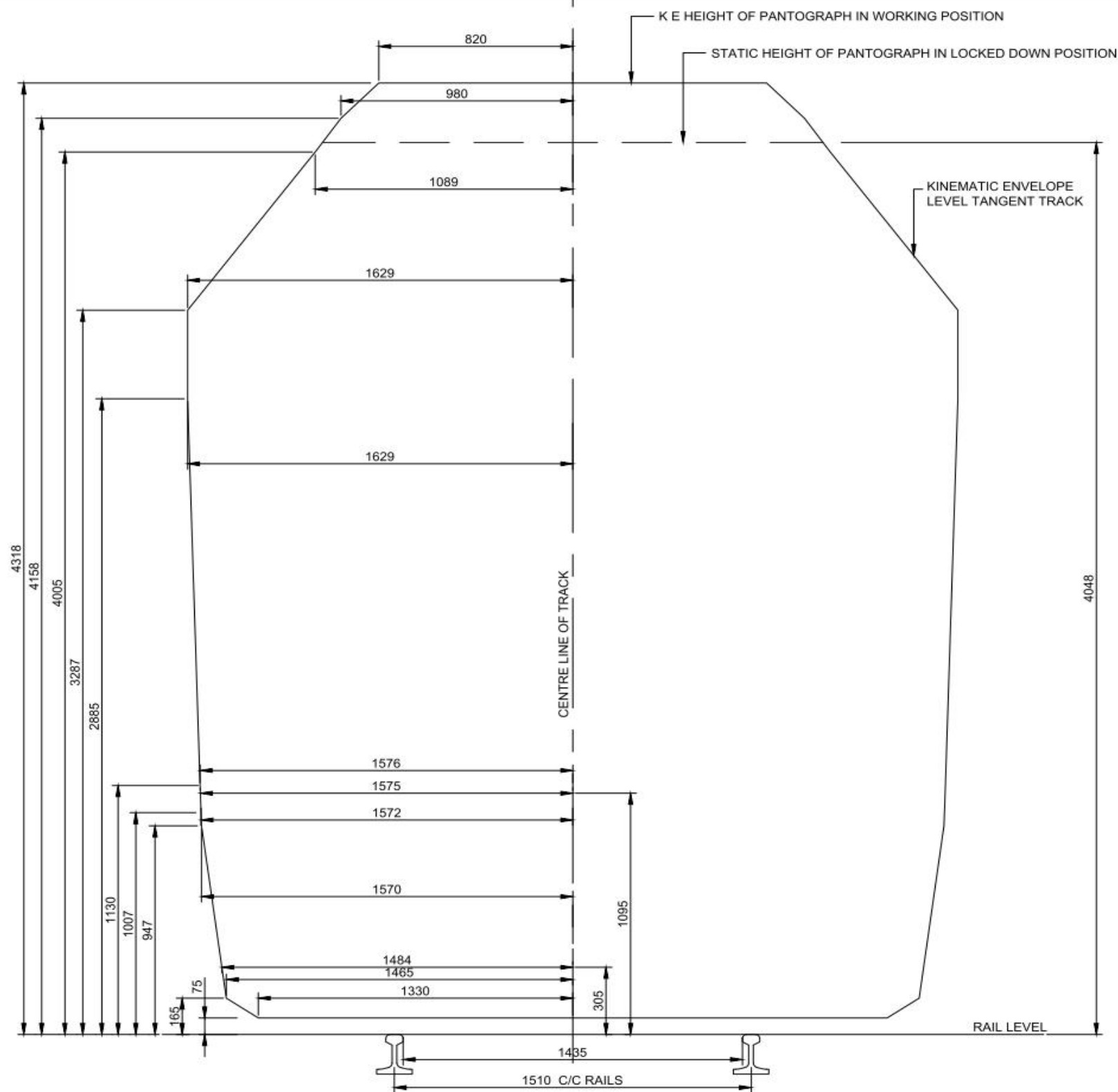
SCALE: NOT TO SCALE

REF: PARA 5.1



PUNE METRO RAIL PROJECT
MAHARASHTRA METRO RAIL
CORPORATION LIMITED

STANDARD GAUGE
(1435 mm)
25 kV A.C. TRACTION

**NOTE:**

1. ALL DIMENSIONS ARE IN mm.
2. HORIZONTAL AND VERTICAL CLEARANCE DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
3. KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
4. A TYRE OR ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR A DISTANCE OF 51mm INSIDE AND 216mm OUTSIDE OF THE GAUGE FACE OF THE WHEEL.
5. CONDUCTOR HEIGHT ABOVE RAIL LEVEL SHALL ALSO TAKE INTO CONSIDERATION PRESCRIBED ELECTRICAL CLEARANCES BETWEEN ALL LIVE OVERHEAD EQUIPMENT AND PANTOGRAPH / VEHICLE AND ALL PARTS THEREOF.

TITLE:
KINEMATIC ENVELOPE UNDER GROUND SECTION (TUNNELS)
(OUTSIDE STATION)
ON
LEVEL OR CONSTANT GRADE TANGENT TRACK

FIGURE NO. PMSG-8

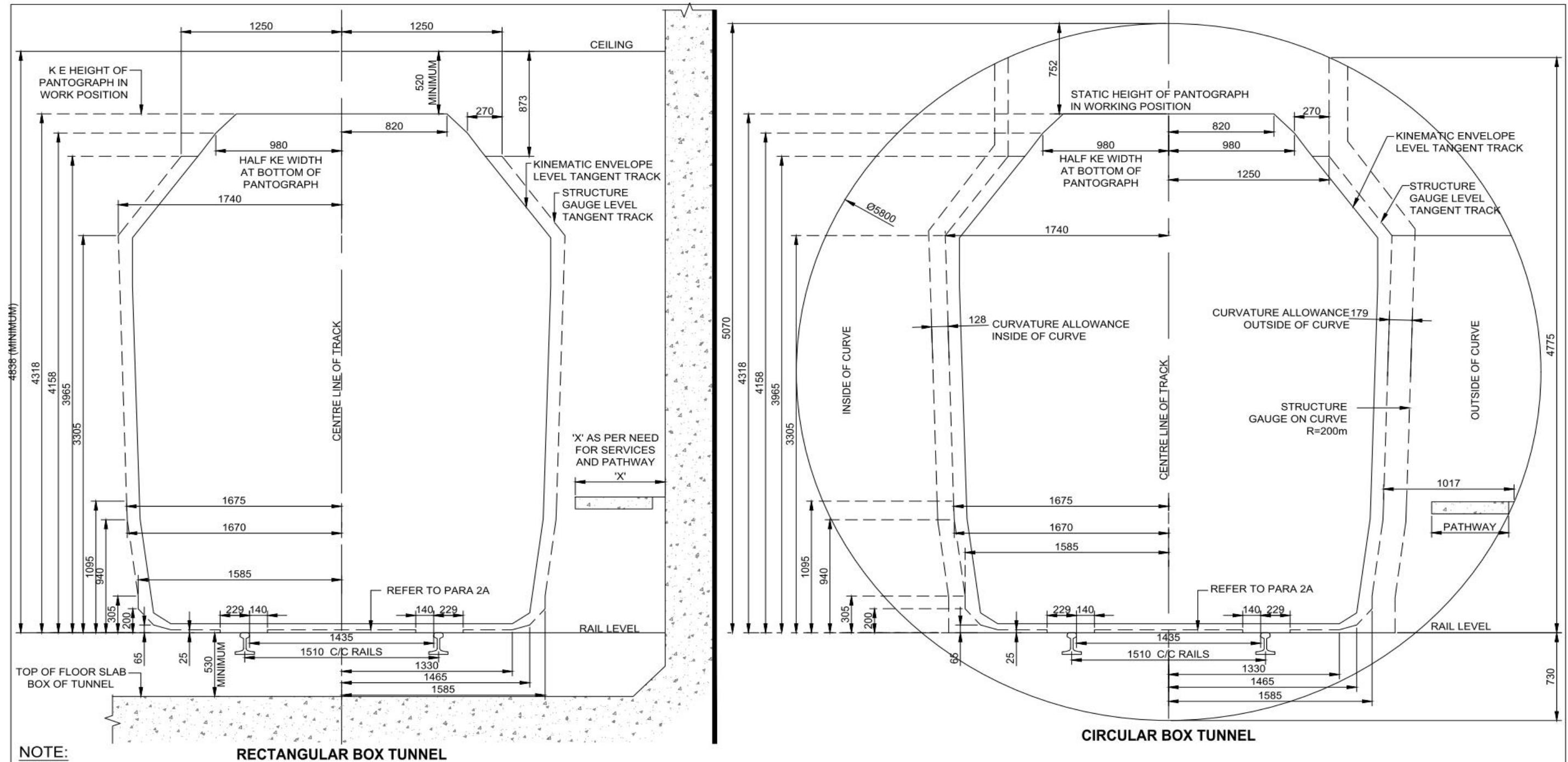
SCALE: NOT TO SCALE

REF: PARA 1.5,3.1,3.2 & 4.2.5



PUNE METRO RAIL PROJECT
MAHARASHTRA METRO RAIL
CORPORATION LIMITED

STANDARD GAUGE
(1435 mm)
25 kV A.C. TRACTION



NOTE:

1. ALL DIMENSIONS ARE IN mm.
2. HORIZONTAL AND VERTICAL SHIFTS DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
3. KINEMATIC ENVELOPE AND STRUCTURE GAUGE ARE VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
4. STRUCTURE GAUGE FOR CURVE DOES NOT INCLUDE LATERAL SHIFT (LEAN) DUE TO CANT.
5. CANT WILL BE PROVIDED BY RAISING OUTER RAIL ONLY AND SHIFTING OF THE CENTRE OF THE CIRCULAR TUNNEL TOWARDS INSIDE OF THE CURVE AND UPWARDS. THIS WILL BE SAME AS ROTATING THE CIRCULAR TUNNEL ABOUT THE MID POINT OF TOP OF INNER RAIL.
6. MINIMUM CLEARANCE BETWEEN KINEMATIC ENVELOPE AND STRUCTURE GAUGE=100mm. THE ELECTRICAL CLEARANCE FROM 25 Kv LIVE PARTS AND EARTHED STRUCTURES SHALL BE 270mm.
7. VERTICAL THROW DUE TO VERTICAL CURVE HAS NOT BEEN SHOWN IN THE FIGURE AND SHALL BE EXTRA.
8. PATHWAY / WALKWAY LOCATION IS INDICATIVE.

TITLE:
STRUCTURE GAUGE
ON LEVEL OR CONSTANT GRADE TRACK (OUTSIDE STATION)
CIRCULAR TUNNEL (5800 DIA) ON TANGENT TRACK AND ON
CURVE OF R=200 M BALLASTLESS TRACK RECTANGULAR BOX
TUNNEL ON TANGENT TRACK

FIGURE NO. PMSG-9

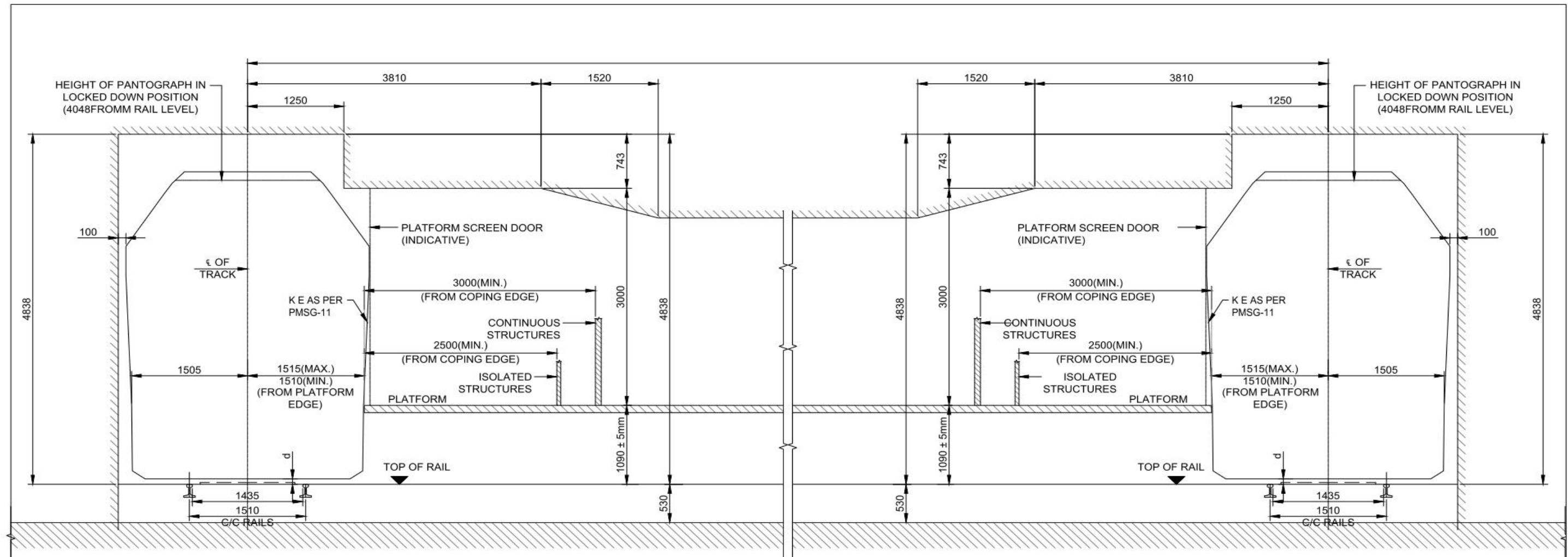
SCALE: NOT TO SCALE

REF: PARA 1.4, 1.6



PUNE METRO RAIL PROJECT
MAHARASHTRA METRO RAIL
CORPORATION LIMITED

STANDARD GAUGE
(1435 mm)
25 kV A.C. TRACTION



NOTES:~

1. ALL DIMENSION ARE IN MM.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. VERTICAL THROW DUE TO VERTICAL CURVE IF ANY SHALL BE EXTRA.
4. THE STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOW AND DOORS CLOSED WHILE IN MOTION.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51mm INSIDE AND 216mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE 102mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE, AND 50mm UNDER DYNAMIC CONDITION.

TITLE:
STRUCTURE GAUGE AT UNDERGROUND
STATION WITH ISLAND PLATFORM
LEVEL OR CONSTANT GRADE TANGENT TRACK

FIGURE NO. PMSG-10

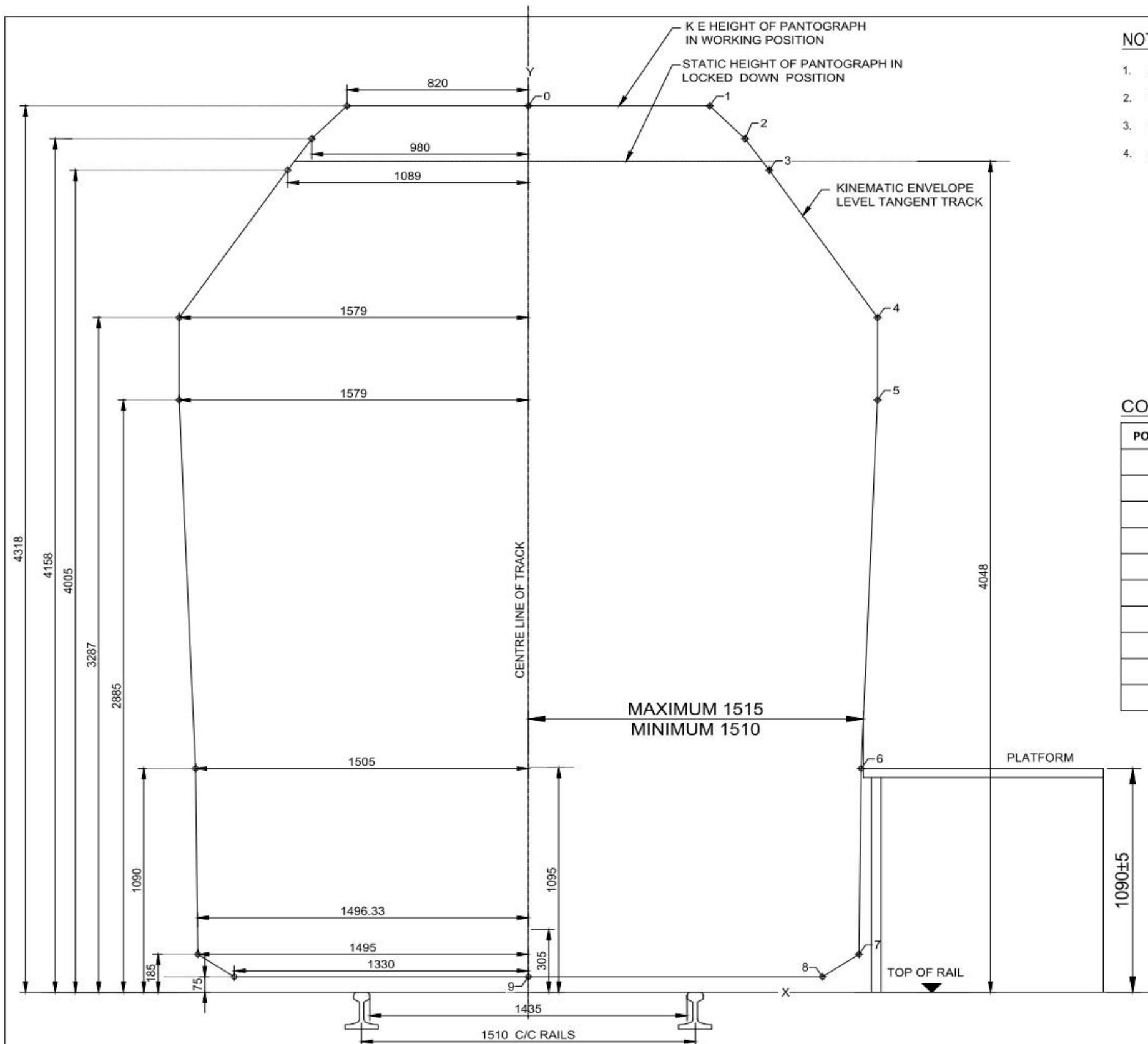
SCALE: NOT TO SCALE

REF: PARA 2.2.4



PUNE METRO RAIL PROJECT
MAHARASHTRA METRO RAIL
CORPORATION LIMITED

STANDARD GAUGE
(1435 mm)
25 kV A.C. TRACTION



NOTES:~

1. ALL DIMENSIONS ARE IN mm.
2. HORIZONTAL AND VERTICAL CLEARANCE DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
3. KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHEN IN MOTION.
4. KINEMATIC ENVELOPE IS VALID FOR 70 KMPH OPERATING SPEED.

CO-ORDINATES

POINT #	EASTING (X')	NORTHING (Y')
0	0	4318
1	820	4318
2	980	4158
3	1089	4005
4	1579	3287
5	1579	2885
6	1505	1090
7	1495	185
8	1330	75
9	0	75

TITLE:

**KINEMATIC ENVELOPE
UNDERGROUND SECTION
ON
LEVEL OR CONSTANT GRADE TANGENT TRACK
AT PLATFORM**

FIGURE NO. PMSG-11

SCALE: NOT TO SCALE

REF: PARA 1.5, 3.1 & 3.2



PUNE METRO RAIL PROJECT
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**STANDARD GAUGE
(1435 mm)
25 kV A.C. TRACTION**

$$\tan \theta = (r - D_1) / (g/2)$$

$$\theta = \tan^{-1} [(r - D_1) / (g/2)]$$

$$\sin \alpha = \text{cant} / g$$

$$\alpha = \sin^{-1} (\text{cant} / g)$$

$$\text{Chord } C_1 C_2 = 2 \times [(r - D_1) / \sin \theta] \times (\sin \alpha / 2)$$

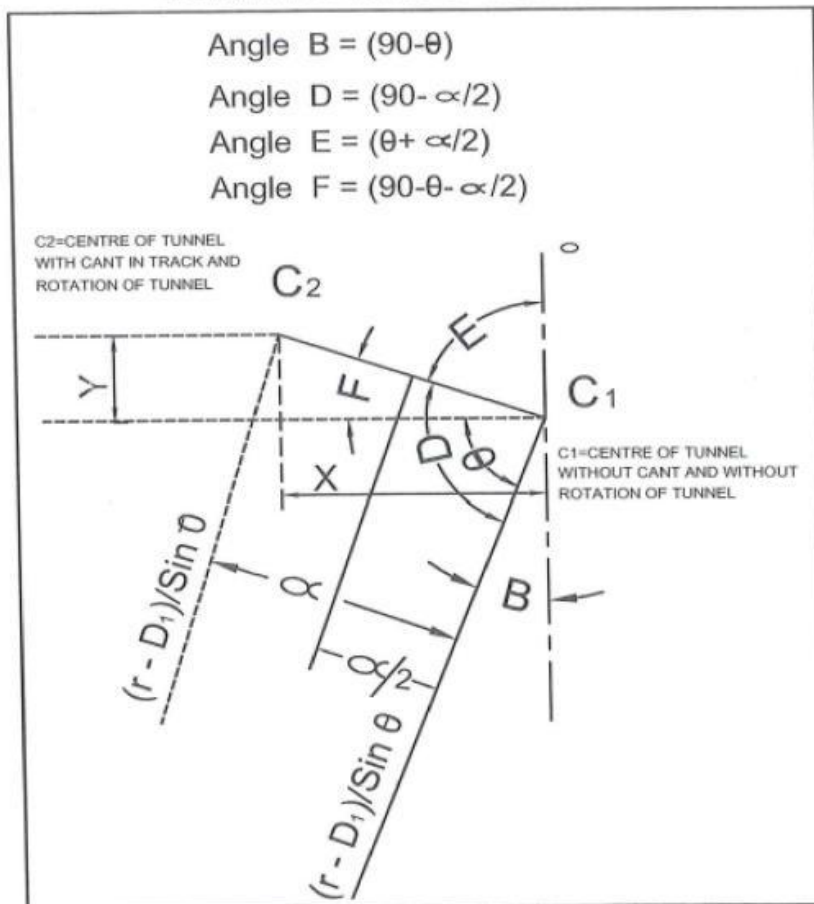
$$X = C_1 C_2 \times \cos (90 - \theta - \alpha / 2)$$

$$= 2 \times [(r - D_1) / \sin \theta] \times (\sin \alpha / 2) \times \cos (90 - \theta - \alpha / 2)$$

$$Y = 2 \times [(r - D_1) / \sin \theta] \times (\sin \alpha / 2) \times \sin (90 - \theta - \alpha / 2)$$

Where 'r' is internal radius of tunnel,
 D_1 = depth from Rail level to invert of tunnel
 g = distance between centres of rails
 = 1510 mm

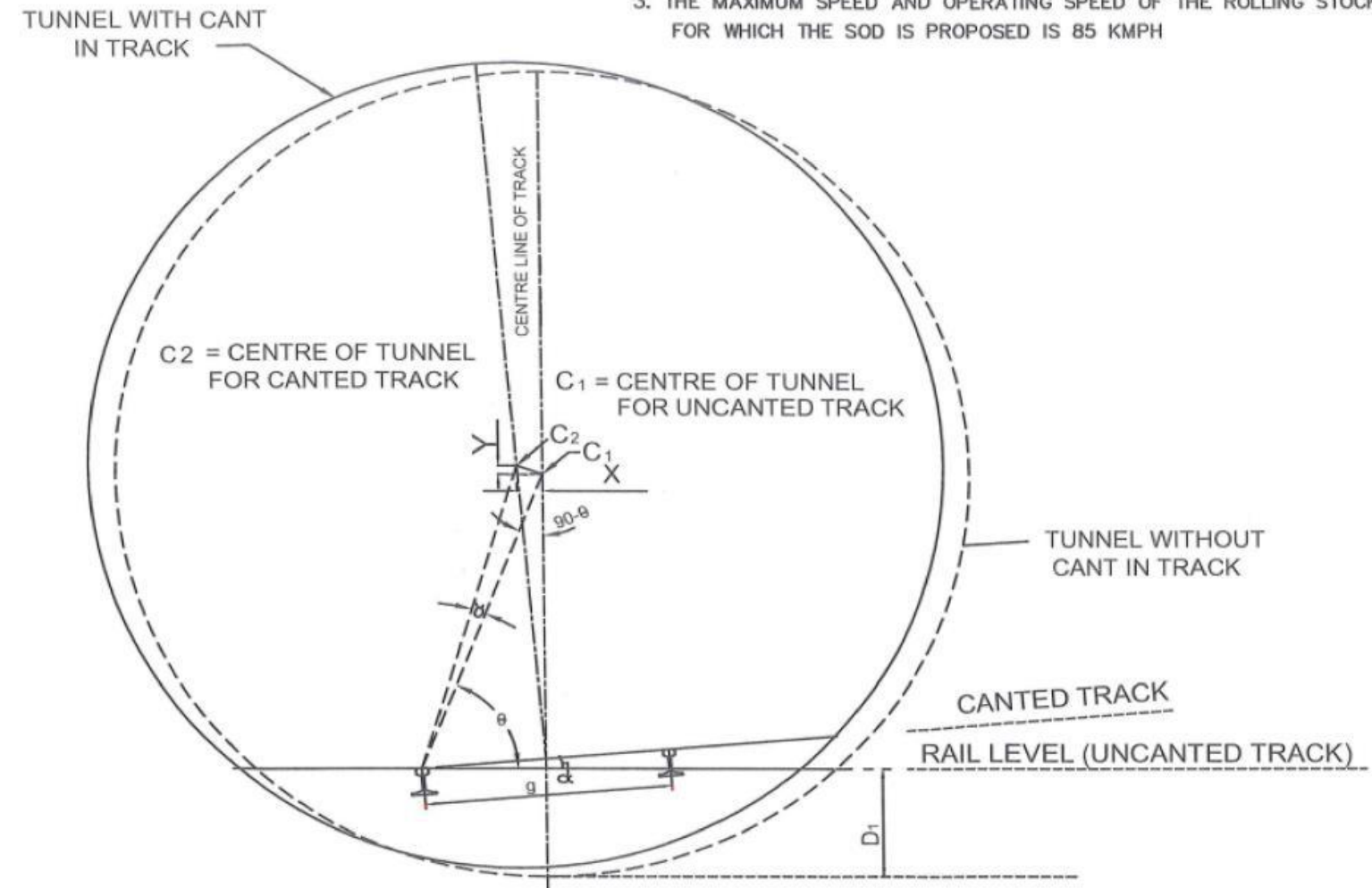
DETAIL AT CENTRE OF TUNNEL



STANDARD GAUGE
 (1435 mm)
 25 KV A.C TRACTION

NOTES:

1. THE CIRCULAR TUNNEL IS ROTATED ABOUT THE MID POINT OF TOP OF INNER RAIL FOR CANT.
2. FOR VALUES OF SHIFT 'X' AND 'Y' FOR VARIOUS VALUES OF CANT, REFER TO APPENDIX -4
3. THE MAXIMUM SPEED AND OPERATING SPEED OF THE ROLLING STOCK FOR WHICH THE SOD IS PROPOSED IS 85 KMPH



SHIFT OF THE CENTER OF CIRCULAR TUNNEL DUE TO
 ROTATION OF TUNNEL TO PROVIDE CANT

FIGURE NO PMSG - 12

SCALE: NOT TO SCALE



PUNE METRO RAIL PROJECT
 MAHARASHTRA METRO RAIL
 CORPORATION LIMITED

STANDARD GAUGE
 (1435mm)
 25 KV A.C. TRACTION

Maha Metro



Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 19 – Design and Construction Interface Management

June 2018

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DESIGN AND CONSTRUCTION INTERFACE MANAGEMENT

1. DEFINITIONS AND ABBREVIATIONS

- 1.1 Chief Interface Coordinator means a suitably qualified person, assigned by the Contractor, who is the Team Leader responsible for administrating, monitoring, managing, supervising, coordinating and resolving all interface issues between Interfacing Contractors for the Pune Metro Project.
- 1.2 Combined Services Drawings (CSD) means those drawings produced by the Contractor, showing the locations, layouts, sizes and details of all services, including those of Interfacing Contractors (All Project Contractors), such as equipment, cables, other services, cable containment, pipes, etc. complete, co-ordinated so as to eliminate all clashes. These drawings are to be used to enable all equipment, pipes, cables, etc. to be installed without conflict and to enable future changes or modifications to be performed without impacting the existing installation.
- 1.3 Interface means the region of interaction across the common boundary between two adjacent but separately managed and controlled parts (or Contracts) of the Project. The coordination and management of the interaction regions is necessary to ensure that the overall scope and definition of the Project works is complete and seamless across all such boundaries.
- 1.4 Interfacing Contractors means any of the following whose activities or the works they are engaged to carry out in any way or at any time affect or are affected by the Works:
 - (a) Project Contractors and design or specialist consultants engaged on the Project from time to time by the Employer, the Government of Republic of India, the Government of Maharashtra or the utility providers;
 - (b) utility providers;
 - (c) developers or franchisees appointed on the Project from time to time by the Employer;
 - (d) subcontractors of any tier of the contractors within category (a) above, and contractors and subcontractors of any tier of utility providers, developers and franchisees within categories (b) and (c) above;

Provided that the definition shall exclude the Contractor and his subcontractors of any tier in relation to the Works and in any other capacity which would otherwise fall within categories (a) to (d) above in relation to other works.
- 1.5 Interface Coordination Sheet (ICS) means a document produced by the Contractor which defines the integration and interfaces between his Contract and the Interfacing Contractors employed on the Project.
- 1.6 Interface Management Programme (IMPG) means the programme produced by the Contractor, developed and updated on a quarterly basis, which describes the sequence and timing of each of the Interfacing Contractors’ scope of work, and clearly describes dependencies between his Works and the work of the Interfacing Contractors.
- 1.7 Interface Management Plan (IMP) means the Report prepared by the Contractor,

developed and updated on a quarterly basis that provides a clear description of his interfaces both sequentially and technically as specified in the Contract or as additionally identified by the Contractor/Interfacing Contractors. The report will be reviewed in accordance with this procedure and is a pre-requisite to the Engineer’s Notice of No Objection.

- 1.8 Interface Specification (IS) means the specification document developed by the Lead Contractor for the interfacing part of his Project/Contract on the basis of, and by integrating into his design, the information provided by the Interfacing Contractor(s), in accordance with the interface agreements as contained in the ICS. The Interface specification needs to be agreed upon by both the Lead Contractor and the Interfacing Contractor(s), before it is submitted to the Engineer for Notice of No Objection (NONO).
- 1.9 Master Interface Matrix (MIM) means the document developed by the Engineer, which may be updated, and/or expanded to include additional Interfacing Contractors, by the Engineer as the Project progresses. The purpose of the Master Interface Matrix is to allocate which Interfacing Contractors are the lead party(s) for each contract.
- 1.10 Structural, Electrical and Mechanical Drawings (SEM) means those drawings produced by the Contractor, showing the locations, sizes and details for all structural openings, plinths, embedments, sumps, floor chases, etc. required for the installation of all equipment, cable trays, pipes, etc...
- 1.11 Zone of Interface means where two or more components of the railway (Metro System) provided by two or more Interfacing Contractors combine to provide a single element.

2. INTRODUCTION

- 2.1 Interface and co-ordination of the Works will include the co-ordination of all design, technical and programming matters with the various Interfacing Contractors to achieve fully co-ordinated construction and installation of the facilities.
- 2.2 This Appendix 19 describes the Contractor’s responsibilities with regard to interface management and coordination with those Interfacing Contractors who are responsible for undertaking work, which interfaces with the Contract. The Contractor’s responsibility for interface coordination shall include currently defined Interfacing Contractors and those who may be identified in the future. This responsibility is not limited to a particular number of Interfacing Contractors.
- 2.3 The Contractor’s responsibility for interface co-ordination shall include identification of Interfacing Contractors and those who may be subsequently identified during the course of the Contract with whom the Contractor will need to interface and coordinate the Works. This in no way detracts from the fact that the Contractor remains solely responsible for identifying, liaising, and co-ordinating with all Interfacing Contractors in relation to the Works.
- 2.4 The Engineer will monitor and oversee the interface Management activities by the Contractor and will specifically provide direction or information in the following

circumstances.

- (a) When the interfacing contract has not yet been awarded
- (b) When common agreement cannot be reached between the interfacing parties
- (c) When it is in the interest of the project programme, quality or safety to issue direction.

Direction or information provided by the Engineer wherever necessary, shall not in any way relieve the Contractor of his full responsibility to ensure the correctness, accuracy and suitability of the interface implementation and the required specification.

- 2.5 The Contractor shall at all times, use his best endeavours to resolve all interfaces applicable to the Contract and shall be proactive in seeking out interface issues and their solutions.
- 2.6 The Contractor shall ensure that all of the above Interface requirements are included in his Interface Management Plan, refer to Clause 6 of this Appendix 19. Flow charts illustrating the process of entering into an Interface agreement and Monitoring its progress with the help of the Interface Coordination Sheet are provided as Attachments A & B of this Appendix. Figure 1 gives a schematic presentation of the Interface Communication and Coordination processes between the various role-players in the Project.
- 2.7 The Contractor's internal sub-contractors' and suppliers' interfaces are the sole responsibility of the Contractor and are not covered in this Appendix. However, the Contractor shall co-ordinate and manage these interfaces in such a way as to identify and cater for the requirements of the Interfacing Contractors and domestic interfaces, including but not limited to, the avoidance of clashes and sequencing of Works. The Contractor shall compile an internal IMP for his own use, a copy of which shall be furnished to the Engineer on request at any time.

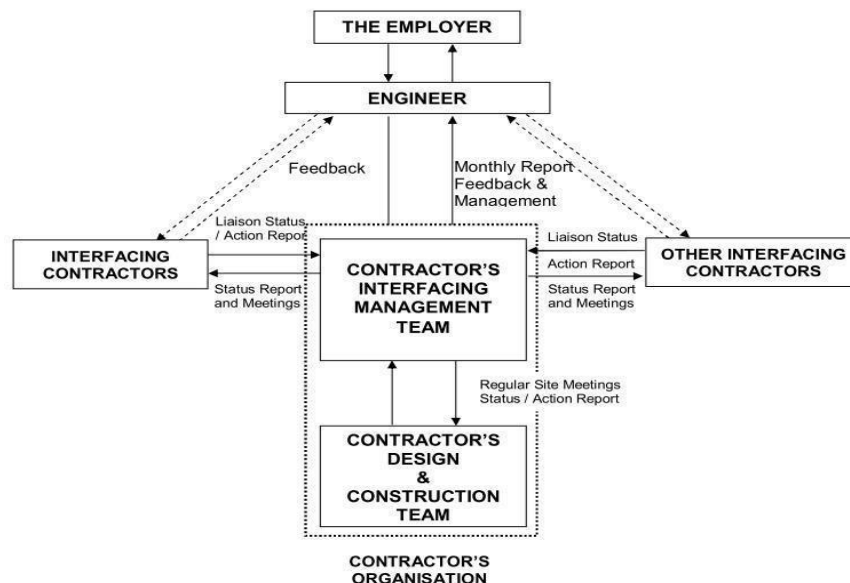


Figure 1 - Interface Communication and Coordination Model.

3. CO-ORDINATION

3.1 Contractor’s Co-Ordination Responsibilities

The Contractor shall co-ordinate with the Engineer and may be required to attend meetings on issues appertaining to Government authorities and utility agencies regarding the services/facilities to be provided by them for the project.

The Contractor shall ensure that the work of all Interfacing Contractors can be carried out in accordance with the Interface Management Plan prepared by the Contractor.

3.2 Site Co-Ordination & Attendance

3.2.1 The Contractor shall, at his own cost, provide all attendance on and co-ordination with Interfacing Contractors. The following items are not a comprehensive or exhaustive list of the co-ordination or interface attendance items to be provided for the Interfacing Contractors’ use, but are intended to provide an outline of the content of amenities, services and facilities for which the Contractor is responsible:

a) Single point of contact for meetings, actions, planning, scheduling and co-ordinating.

b) Site access

The Contractor shall co-ordinate with the Interfacing Contractors and provide access and use of temporary access roads to and from and within the Site. The Contractor shall co-ordinate all vehicle movements, deliveries and other activities with the Interfacing Contractors so as to ensure that conflicts of use are controlled on and around the Site.

c) Storage and Accommodation area

The Interfacing Contractors will require limited temporary site accommodation and storage areas. The Contractor shall agree with the Interfacing Contractors access and areas for storage and temporary site accommodation prior to their commencing work on Site.

d) Work space requirement and sequence of Works

e) Shared use of Contractor’s scaffold

The Contractor shall co-ordinate with the Interfacing Contractors and provide free use and shared access of his erected scaffolding, ladders and hoists should they be available at the time the Interfacing Contractor requires to use them. Notwithstanding this requirement, the Contractor shall at all times remain responsible for the management of safety and the maintenance of such scaffolding, ladders and landings. The Contractor will not be required to adapt or erect access scaffolds specifically for the use of Interfacing Contractors.

If the Interfacing Contractor erects and uses his own scaffold he will be required to adhere to the Contractor’s safety rules and access routing for equipment and materials. The Contractor shall ensure that all scaffolds of Interfacing Contractors are erected in a safe manner and are subject to permits for use issued by the Contractor.

f) Setting out control points

g) Access Openings

The Contractor will form all penetrations and delivery openings and subsequently close them (either temporary or permanent) for access to rooms or areas for the delivery of equipment and materials.

- h) Temporary lighting requirement will be 100 lux minimum.
- i) Temporary power and water supplies shall have to be provided at agreed locations around the Site for the Interfacing Contractors’ use.
- j) Water tightness. All rooms and areas handed over to Interfacing Contractors shall be in a watertight condition and maintained as such.
- k) Ensure all electrical supplies both temporary and permanent have the correct testing and commissioning certification.
- l) Waste management and disposal
- m) Appropriate protection to finishes, walls, floors, ceilings and equipment using polythene, hardboard, steel plates etc.
- n) Programme agreement for mobilizing and demobilizing
- o) Firefighting and supply and maintenance of fire extinguishing equipment and devices pursuant to the Contractor’s obligations.
- p) Construction interface co-ordination management of penetrations in structures, embedded and cast-in items, etc.
- q) Temporary Drainage
The Contractor shall provide, operate and maintain all necessary temporary drainage, sumps, silt traps and sump pumps to collect and dispose of wastewater from Interfacing Contractors construction processes including installation, testing and commissioning activities.
- r) Sanitation facilities
The Contractor shall provide all sanitation facilities and the disposal of waste. No unauthorised sanitation facility will be allowed on the Site.
- s) Making good and fire stopping, of penetrations
- t) Lifting apparatus and hoists
The Contractor will be required to install all temporary and permanent lifting hooks and beams shown on the drawings and the Specification, required for installation and/or maintenance purposes. The Contractor will be responsible for the testing and labeling of all apparatus. The Contractor will be required to make available any lifting or hoist apparatus on Site as required by the Interfacing Contractor at agreed times and duration for their use. The Contractor shall be responsible for the maintenance testing and operational management of hoists. The Contractor shall make available his cranes for lifting equipment or materials for Interfacing Contractors.
- u) Health and Welfare Facilities
The Contractor shall allow Interfacing Contractors use of his health, welfare and mess facilities, and temporary background lighting. He shall liaise with the Interfacing Contractors to determine their planned and actual manning levels and ensure that sufficient facilities are provided prior to them commencing work on Site. The facilities shall be maintained on Site until the Interfacing Contractors have completed their Works and demobilised or such earlier time as the Engineer may direct.

3.2.2 The Contractor is deemed to have ascertained for himself the full scope of his responsibilities and obligations under the Contract in terms of attendance on and co-ordination with Interfacing Contractors and shall not be entitled to any additional payment, Cost or extension of time for completion should he have failed to do so.

- 3.2.3 The Contractor shall make due allowance for providing Attendance, including power and other utilities’ supplies, throughout all phases of the Interfacing Contractors work including testing and commissioning and where supplies to various Interfacing Contractors need special consideration during testing and performance trials under peak load conditions.

4. INTERFACE

4.1 Co-Ordination of Contractor’s Scope of Work

In accordance with the requirements of the Conditions of Contract and other specified requirements, the Contractor shall co-ordinate his own work with that of all Interfacing Contractors and ensure that the design, construction, installation and testing requirements of the Interfacing Contractors are incorporated into the Contractor’s co-ordinated plans, programmes and Works. The Contractor shall proactively seek out interface issues and solutions.

In addition to the Contractor’s obligations to the Interfacing Contractors contained elsewhere in the Contract, the Contractor shall provide / handover occupation or access as required, to the Interfacing Contractors to those parts of the Works which are subject to Key Dates by the required Key Dates.

The Contractor shall complete those parts of the Works, which are subject to Key Dates, by the required Key Dates that may be specified in the Appendix to Tender and/or Appendix 2B of Section-VI – Employer’s Requirements of this Contract. Those parts of the Works subject to Key Dates shall be completed to a state whereby any Interfacing Contractor can immediately commence his works without the need to make any change, addition or modification to the Contractor’s Works.

4.2 Interfacing Contractors

- 4.2.1 The Interfacing Contractors will require interface and co-ordination for information, programming, drawings acceptance, handover, etc. as shown on the Interface Coordination Sheet enclosed in Attachment F of this Appendix.

However, the Contractor should note that the Interface Coordination Sheet shown herein has been compiled by the Engineer, and is therefore given as example only.

The Contractor’s responsibilities in this respect are in no means restricted by the details listed in such sheets and no warranty is given by the Employer or the Engineer that all interfaces and Interfacing Contractors have been included in such sheets. The Contractor is to confirm and verify all of the details included in the Interface Coordination Sheets, and his review should ensure that all interfaces have been included.

The Contractor shall take overall responsibility for the Interface Coordination Sheets, which must be submitted to the Engineer for a notice of no objection.

- 4.2.2 The Master Interface Matrix (MIM), enclosed in Attachment E, assigns the Contractors which have been designated as the Lead party(s) for each interfacing contractor. The MIM has been developed by the Employer/Engineer, which he may update and/or expand at any time to include additional Interfacing Contractors, and the Contractor’s Contract price shall be deemed to include any such additional works related to interfacing or Interface Management. The leading Interfacing Contractor shall be responsible for administrating, monitoring, managing, supervising and

resolving all interface issues between all Interfacing Contractors.

4.2.3 In a situation when the Lead Contract has not yet been awarded and the Interfacing contractor has commenced work, the Engineer will perform the coordination activities including preparation of tentative ICS / Interface Specification, with the express understanding that they may undergo changes as and when the Lead Contractor commences his work on being awarded the Contract.

4.2.4 Where an interfacing contract has yet to be awarded, the Lead Contractor shall proceed with the coordination activities (including preparation of ICS and Interface specification) as instructed by the Engineer until such time when the Interfacing Contractor is available.

4.3 Interfacing Contractors - Communications and Information Exchange

4.3.1 GENERAL

- a) The Contractor shall communicate, co-ordinate and exchange information directly with the Interfacing Contractors and the Contractor shall keep the Engineer advised at all times. Information necessary to fulfil the Contractor’s interface obligations shall be directly requested and obtained from the Interfacing Parties, and receipt acknowledged. Conversely, the Contractor shall provide directly to the Interfacing Contractors information within the Contractor’s scope that is required by them.
- b) All requests for information, acknowledgement of receipt of information, and any official communication between the Contractor and the Interfacing Contractors shall be made in writing, with a copy to the Engineer for his information. The Engineer shall be invited to attend all interface meetings between the Contractor and the Interfacing Contractors. Irrespective of whether these meetings were attended by the Engineer or not, the Contractor’s monthly progress report to Engineer shall invariably include the details of all interface meetings held and decisions arrived.
- c) The Contractor’s programme shall allow time for the availability of necessary interface information from the Interfacing Contractors and in this regard the Contractor shall, where required, proceed on a late start basis to allow adequate time for others to provide required information and thereby achieve design process compatibility.
- d) The Contractor shall allow for the fact that many of the design and construction activities for the different contracts will be proceeding concurrently. In the event that certain interface information is not forthcoming at the time targeted, the Contractor shall be responsible to resolve the matter with the relevant Interfacing Contractor without recourse to the Engineer, and where necessary develop alternative interim arrangements such that the interface information may be accommodated at a later date.
- e) Definitive dates for transfer of information and particular interface actions shall be confirmed between the Contractor and the Interfacing Contractors.

4.3.2 INTERFACING FUNCTIONS

The Interfacing Contractors are responsible for, but not limited to, the following;

- the management of Contract to Contract Interfaces as required;
- preparing the Interface Management Plan and subsequent procedures;
- preparing their Interface Management Programmes in accordance with this procedure and submitting these to the Interfacing Contractors for concurrence;

- preparing the Interface Management Programmes and submitting these to the Engineer for a Notice of No Objection;
- preparing their Interface Coordination Sheets and Interface Specifications and issuing same to the relevant Interface Contractors and Engineer;
- co-ordinating with the relevant Interface Contractors to establish coordinated CSD & SEM Drawings;
- maintaining their ICS updated continuously and attaching it to their Monthly Progress Report submitted to the Engineer in accordance with the requirements of the Contract and this Appendix.

4.3.3 DOCUMENTATION REVIEW

The Contractor shall, as a minimum:

- review those portions of the Specification and Drawings relevant to the interface and transmit such information to the Interfacing Contractors;
- co-ordinate and co-operate with Interfacing Contractors on all Site related matters including, but not limited to, Site access and occupation, attendance, safety, verification of work compatibility, survey control, etc...;
- review the interface information received and agree in writing with the Interfacing Contractors that the interface information is adequate for that stage of that activity.

4.3.4 DESIGN STAGE

The design interface is an iterative process, thus throughout the design process, the Contractor shall be responsible for coordinating his own design with Interfacing Contractors to develop interface designs in conjunction and co-operation with the designers of Interfacing Contractors. These interface designs will be monitored and have to be given Notice of no objection by the Engineer, but the Contractor shall work directly with the Interfacing Contractors to develop designs which are mutually acceptable to all parties.

The Contractor shall, immediately upon Contract Award, gather all necessary information and develop his design to a level where meaningful interaction can take place as soon as the Interfacing Contractors are available.

4.3.5 INTERFACE DESIGN CHANGE PROCESS

The Contractor shall establish an interface design change process to ensure that:

- All proposed changes for a specific interface are reported, recorded and resolved;
- Proposed changes are fully evaluated; and
- Internal/External communications and distribution paths are properly defined

4.3.6 CONSTRUCTION PHASE

During construction the Contractor shall, when a construction item is ready for field inspection, advise the Interfacing Contractor in advance to verify compatibility with the Interfacing Contractor's needs.

The Contractor shall:

- advise the Interfacing Contractors in writing when the as-constructed interface-related work can be inspected, and provide the necessary Site access and occupation;

- request in writing and obtain from the Interfacing Contractors, interface information required for that stage of the Contract;
- agree in writing with the Interfacing Contractors on the adoption of any applicable comments on the constructed work;
- agree that any testing and commissioning for works can be carried out in accordance with the Interface Management Plan;
- conduct on-Site inspections of the work elements, and give comments in writing to the Interfacing Contractors;
- agree in writing with the Interfacing Contractors that the as-constructed work meets the interface requirements.
- Where the execution of work by Interfacing Contractors depends upon the Contractor’s site management or upon information to be given by the Contractor, the Contractor shall provide the Interfacing Contractors with the required services or the correct and accurate information required to enable the Interfacing Contractors to meet their programme for the construction or installation of their works.

4.3.7 INTERFACE COMMISSIONING

The Contractor shall co-ordinate all of his testing and commissioning activities with the Interfacing Contractors. Interface commissioning shall demonstrate that the delivered interface, part A of the interface, is ready and meets the interface requirements of the interface part B, and vice versa.

Successful completion of all interface commissioning shall prove its readiness for commissioning of the overall Contract scope and completion of the overall Metro-rail Project, prior to handover to the Employer for their commercial operation.

4.4 Resolution of Co-ordination Difficulties

When the Contractor identifies interface co-ordination difficulties, the Contractor shall review the pertinent points of each Interfacing Contractor to determine possible compatible solutions in terms of sequence, timing and technical details. The Contractor shall then meet with the relevant Interfacing Contractor(s) to determine solutions, which are mutually acceptable to each Interfacing Contractor and advise the Engineer.

Where an acceptable solution has not been identified, the Contractor shall advise the Engineer in writing of the problems encountered. If, in the opinion of the Engineer, an interface is not proceeding satisfactorily, then the Engineer will review the matter, and establish a co-ordinated plan directing the Contractor and the Interfacing Contractor(s) on the required action. In the event that no agreement can be made between the Contractor and the Interfacing Contractor(s), the Engineer shall determine the requirements to the best of his knowledge, and his determination shall be final and binding on the Contractor and the Interfacing Contractor(s).

4.5 Interface Performance

The Contractor’s performance in relation to his compliance with the interface requirements under the Contract shall be assessed by the Engineer 3 months after the Commencement Date and thereafter at three monthly intervals. The assessment will be in the form of an audit of the Contractor’s interface management system. This audit will assess the Contractor’s compliance with the responsibilities delineated in

this Appendix and elsewhere as related to interface management and the preparation of the Interface Management Plan and Programme and other documentation and procedures associated with Interface Management and Coordination.

The Contractor will be notified of non-conformances from the audit, which will require rectification. Where, in the opinion of the Engineer, the Contractor has failed to rectify a non-conformance within a reasonable period from the date of notification, this may lead to non-payment of any lump sums, until such time as the non-conformance has been rectified to the satisfaction of the Engineer, refer sub-clause below.

The Contract allows for continuous audits of the Contractor’s compliance with his Interface Management Plan and the requirements of this Appendix 19 of Section-VI Employer’s Requirements, and any extreme or continuing failures shall result in a negative audit report, which may lead to non-payment of the relevant payment item in the Preliminaries section of the Pricing Document. The decision of the Engineer in this regard shall be final.

5. CONTRACTOR’S INTERFACE MANAGEMENT SYSTEM

5.1 Interface Management System

The Contractor shall establish and maintain an Interface Management System to identify, control and monitor the interfaces of the Contract, which shall include, but not be restricted to, the following:

- Establishment and maintenance of an Interface Management Team suitably qualified and experienced in co-ordination and interface management.
- Provision, as one of his Key Personnel, of a Chief Interface Co-ordinator, to head the Interface Management Team, suitably qualified and experienced as noted in Sub-division A of this Section-VI, Employer’s Requirements, with the responsibility, experience and authority to resolve interface matters in accordance with the Contract. The Chief Interface Co-ordinator will develop a monitoring and reporting procedure to be implemented by his team for the duration of the Contract.
- Implement and maintain a strict monitored control of information transfer to the Interfacing Contractors, the Employer and the Engineer utilising the official channels of communication.
- Provide a comprehensive interface schedule of Interfacing Contractors, including specialist domestic interfaces (i.e. specialist testing and commissioning engineers) identifying all interfacing activities and timetables of events.
- Arrange all internal and external interface meetings. The Engineer may arrange regular meetings to monitor the status of interfaces, and may require special meetings as may be necessary to resolve specific issues. The Contractor’s Interface Management Team will be required to attend such meetings. The Contractor may request assistance from the Engineer to arrange meetings on particular subjects.
- Providing the Engineer with all information and/or details of interfaces, including copies of all correspondence and material.
- Providing the Engineer with access to information for the purpose of

conducting audits on the interface system and for confirming that interface co-ordination is proceeding consistently with the Project requirements.

- Establish interface dates for information, documentation, access or works completion requirements.

5.2 Interface Management Team

The Contractor’s Interface Management Team will undertake and fulfil the following tasks:

- Provide timely interface information when requested, anticipating the information needs of the Interfacing Contractors and transmitting such information as soon as it is available.
- Pro-actively keep the Interfacing Contractors informed of any development of the Works related to the interfaces. Communicating and co-operating with the Interfacing Contractors to identify and resolve potential interface problems.
- Advise the Interfacing Contractors on potential problems related to the interfaces, together with proposed solutions likely to be acceptable to Interfacing Contractors and which meet the needs of the Project.
- Arrange and/or attend meetings with the Interfacing Contractors as necessary to resolve interface issues.
- During each stage of the Contract, the Contractor shall directly communicate and co-ordinate with Interfacing Contractors as necessary to achieve a fully co-ordinated design / construction / installation.
- Contractor shall issue true records of all interface meetings, with appropriate actions and attendance lists, to all Interfacing Contractors, whether in attendance or not, and to the Engineer, within 3 days of the meeting. Minutes of meetings shall be signed by all parties in attendance, signifying their agreement to the contents thereof, before being formally issued by the Contractor.

The authority and responsibilities of all personnel involved in the Interface Management Team must be clearly defined in the IMP.

6. INTERFACE MANAGEMENT PLAN & INTERFACE MANAGEMENT PROGRAMME

6.1 General

The Contractor shall prepare the proposed Interface Management Plan and proposed Interface Management Programme, in accordance with the Contract stipulations and based on the formats noted in Attachments H and I, to which the Engineer issues a notice of no objection. The Interface Management Plan and Interface Management Programme shall completely define the Contractor’s programme and methodology for interface co-ordination and management, whilst complying with all Key Dates stated in Appendix 2B of this Section-VI Employer’s Requirements.

Subsequently they shall be kept up to date and submitted on a quarterly basis to the Engineer for scrutiny and notice of no objection, and a summary of the principal issues shall be included in each Monthly Progress Report. The Contractor shall note that each submission of these documents is subject to regular audits and the issue of a notice of no objection by the Engineer.

6.2 Interface Management Programme (IMPG)

The Interface Management Programme describes the sequencing and timing of each of the Interfacing Contractors’ scope of work, clearly describing the interdependencies for all stages of the work between the Contractor’s works and that of the Interfacing Contractors and complementing the Interface Management Plan, whilst complying with all Key Dates stated in the Appendix 2B of this Section-VI Employer’s Requirements.

The programme shall be structured to detail each of the primary zones of interface and the principal elements of the design and of the works requiring interfacing contribution from others. This Interface Management Programme shall also be related to the Contractor’s Works Programme and shall show the sequences and timing agreed with the Interfacing Contractors to the necessary degree of detail to clearly illustrate each of the interfaces to be undertaken.

Targets to receive or supply information shall also be shown, with due allowance being given for the design process of others. Information relating to Contractual Key Dates and information exchange dates shall be shown for both the Contractor and the Interfacing Contractors to demonstrate a matching of design processes.

A record of these interfaces, with current status and agreed dates for information transfer, site inspections, access, occupation, handover, etc. shall be maintained and also identified on the ICS, refer Clause 7 below.

Refer to Attachment H - Guidance Notes for the Preparation of IMPG.

6.3 Interface Management Plan (IMP)

The Interface Management Plan is that document which describes the Contractor’s interface management in terms of providing a clear description of each of the interfaces, both technically and sequentially, and represents an account of how the Contractor proposes to achieve co-ordination of the Works. The description shall completely detail the Contractor’s work scope and interface with each of the Interfacing Contractors in terms of technical description, sequence and timing for each of the elements required to achieve a coordinated design. The Contractor shall demonstrate how potential interface conflicts can be eliminated by design simplification. This document is also required to demonstrate that the co-ordinated design and construction details described therein fully comply with the needs of others, and agreement in writing of these details by the Interfacing Contractors will be a pre-requisite to the Engineer issuing a notice of no objection.

Refer to Attachment I – Guidance Notes for the Preparation of IMP.

6.4 Requirements For The Interface Management Programme & Interface Management Plan

The Interface Management Programme (IMPG) shall be a process-driven programme in a format to be agreed with the Engineer. The IMPG shall incorporate the key activities from both the Interfacing Contractors’ and Contractor’s Works programmes that will enable the Contractor to demonstrate that any Interface is being correctly managed and will result in fully co-ordinated design / construction / installation of works.

The Interface Management Plan and Interface Management Programme shall:

- Follow the outline structure, numbering system, and related procedures in a format to be agreed with the Engineer.

- Be co-ordinated with the Interfacing Contractors to ensure compatibility of interface identification and definition.
- Comply with the Key Dates stated in the Appendix 2B of this Section-VI Employer’s Requirements.
- Be transmitted to the Interfacing Contractors concurrently with submittals to the Engineer.
- Support the Works Programme to which the Engineer has given a notice of no-objection.
- Address each zone of interface, i.e., ancillary buildings, train stabling, trackwork external, trackwork internal, substations, signalling and telecommunications facilities, operation and control rooms, staff accommodation, external works etc. related to each design submission and stage of design / construction / installation.
- List all relevant interfaces in detail, their status, and the corresponding source(s) of information.
- Include interface information transfer dates which have been agreed by the Interfacing Contractors.
- Accommodate comments and input required by the Engineer.
- Include an account of how the interfaces are being managed.
- Identify the latest information regarding agreements with the Interfacing Contractors and transfers of information.
- Review and address the design, supply, installation, testing & commissioning programme of the Interfacing Contractors to ensure that the Key Dates of each contract can be achieved, and highlight any programme risks requiring management attention.
- Identify any problems related to co-ordination with Interfacing Contractors.

6.5 Interface Specification.

- 6.5.1 The Interface Specification, proforma enclosed in Attachment C, and associated drawings shall specify the proposed method and schedule for verifying the interface integrity, the individual equipment / system performance and the combined system performance.

The Interface Specification shall include a programme of tests to demonstrate the performance and integrity of the integrated system. The interface sheets developed by the Employer / Engineer are enclosed in Attachment D. The attached interface sheets are not final and do not relieve the Contractor’s obligation to identify any new interface to meet contract requirements. The interface sheets, which the Contractor shall develop, shall be used as a basis to establish the Interface Specification. Any revision to the Interface Specification shall be mutually agreed between the Contractor and Interfacing Contractors, with submission to the Engineer, and shall specifically -

- Understand the design requirements of each party and associated constraints;
- Determine the detailed interface works to be performed during the various stages; and
- Agree on the interface works in reference to respective scope, with any agreements reached to be formally documented in Interface Meeting Minutes, including an actions item list.

- 6.5.2 The Interface Contractors shall mutually identify and agree the Interfaces that will exist between them using the Interface Coordination Sheets, the format of which is contained in Attachment F. These interfaces may be expanded to include all, and any other, interfaces that develop during the execution of the Project.
- 6.5.3 The Interfacing Contractors shall mutually agree upon the information to be exchanged and shall develop a unique Interface Specification for each interface identified. A sample Interface Specification proforma is provided in Attachment C.
- The ICSs will be tracked and monitored using an ICS Register to be compiled by the Contractor. This register will track the progress of the ICS from inception through to closure and final processing by the Contractor, prior to transmittal to the Engineer as a complete Integrated Design.
- Each interface shall have a unique reference number to enable the Interface to be readily identified, tracked and monitored.

7. INTERFACE COORDINATION SHEET (ICS)

- 7.1 The Contractor’s Interface Coordination sheet, the format of which is shown in Attachment F – Part 1, is required to be used by each of the Interfacing Contractors to record all of the Contract Interfaces. The Contractor shall ensure that each Interfacing Contractor provides input and maintains the ICS continually updated as required in this Appendix.
- 7.2 The Contractor shall ensure that the Interfacing Contractors demonstrate their co-ordination efforts as required by the Contract. To achieve this, the Contractor and the Interfacing Contractors shall identify their interface requirements which shall be input into the interface documents, i.e., IMP, IMPG, ICS, etc., by the Contractor.
- 7.3 The Contractor shall monitor the ICS to ensure that, as the Interface progresses, the records show the appropriate Status (refer status codes indicated in Part 3 of Attachment F) as agreed with the Interfacing Contractors. The Contractor will be responsible for confirming the “Closing Out” of each ICS record, whilst ensuring that throughout the interface process all Interfacing Contractors have agreed to the following:
- The receiving Interfacing Contractor has received and accepted the Interface being recorded.
 - All Interfacing Contractors have recorded the interface record as “Proposed Close Out”.
 - The Confirmation of Co-ordination form in Attachment G has been updated and signed by the relevant Interfacing Contractors, refer clause 7.4 below.
- 7.4 When documents are exchanged for review/comment with Interfacing Contractors, the originator preparing these documents should ensure that they are accompanied by the Confirmation of Coordination form in Attachment G. When the Interfacing Contractor returns these documents with comments to the originator, they should be returned with the Confirmation of Coordination form duly completed, confirming coordination and agreement or comment as appropriate, as a record of them having coordinated the interface item. This Confirmation of Co-ordination is to be transmitted to the Engineer upon signing by the Interfacing Contractor(s).

8. COORDINATION DRAWINGS

8.1 General

For the purpose of achieving a Project which is fully co-ordinated with respect to civil, structural, architectural, building services, electrical, mechanical works and interface elements, and to ensure compatibility between different facilities and services, and adequate space requirements, all drawings are to be reviewed and co-ordinated by the Contractor.

The Contractor will provide and issue detailed Interface Working Drawings in terms of items such as; special arrangements, space allocation, cast in items, primary and secondary fixings, grouting of equipment/plinths, drill and fix brackets, embedded and cast-in items and the like.

The drawings shall be prepared by the Contractor and shall also include composite cross-sections and layouts, which show the spatial requirements of all Interfacing Contractors and identify items to be finalised, defined, or resolved.

8.2 Combined Services Drawing (CSDs) And Structural E&M Drawings (SEMs)

The Contractor’s CSDs and SEMs must be clear and sufficiently detailed to unambiguously show the intent of the subject services and the corresponding structure / facility allowances. While these drawings do not have to duplicate all of the details of the Drawings, they must include plans, sections and elevations as required to clearly illustrate the compatible relationship between the different disciplines. Specifically, the drawings will include wall elevation drawings at 1:50 scale (or larger where required) indicating all openings, access panels, reinforcement zones, embedded and cast-in items and the like, and shall be submitted to the Engineer for a notice of no objection.

The CSDs shall show the intended locations, routes and spatial relationships of the individual E&M services, Building Services systems, and installations, Depot Equipment (where applicable), Core Systems installations and other installations, fully co-ordinated with each other and the civil structural and architectural work. The CSDs shall also clearly indicate that effective cable co-ordination has been achieved in terms of cable location or cable trays and the trunking and cable routing.

The SEMs shall show all civil, structural, and architectural requirements for the E&M services, Building Services systems and installations, Builder’s works and the Core Systems and other installations.

Where Builder’s works are required by the Interfacing Contractors, the drawings, details, specification notes and catalogue information and the like shall be obtained by the Contractor from these Interfacing Contractors indicating the builder’s work to be incorporated into the Works. The Contractor shall include details of such Builder’s works in the SEMs and Method Statements as appropriate.

Builder’s work comprises, but is not limited to, the following:

- Construction of plinths, bases, builders bund walls and the like.
- placing and fixing of holding down bolts, lifting beams and hooks and other supporting items;
- supply, fabrication installation, protection, fixing and finishing of supporting steelwork, for equipment and associated accessories;
- casting in of edgings, angles in recesses, ducts, conduit, pipes etc.;

- fixing equipment and associated, brackets, cable containment and fixtures;
- forming of penetrations, sleeves, access panels, holes, chases, recesses, openings;
- All in accordance with the Contract.

The CSD/SEMs shall also be used for the purpose of co-ordinating with the Interfacing Contractors and shall be continuously updated to reflect the latest interface co-ordination. Copies of the CSD/SEM drawings shall be included in submittals to the Engineer.

Where the CSDs or SEMs do not fully co-ordinate with the Site conditions the Contractor shall co-ordinate and propose a solution to the problem. All proposed solutions shall be issued to the Engineer.

8.3 Interface Drawings

For the Interface Drawings, the Contractor shall prepare in diagrammatic format for each interface the demarcation of scope of responsibilities between the Contractor and each of the Interfacing Contractors. The Contractor shall submit all Drawings with interface requirements for a notice of no objection from the Engineer. Any proposed deviation to the Construction Specification or noticed drawings shall be identified and justified with design documentation, details and drawings. The submission shall also identify all interface requirements. The contractor shall develop interface drawings with detailed design and dimensions and submit the same to other interfacing contractors.

8.4 As Constructed Drawings

Upon completion of the Works the Contractor shall submit all Combined Services Drawings, Structural E&M Drawings, and Interface Demarcation Drawings showing the final “As Constructed” status of the Works related to these drawings.

9. ATTACHMENTS.

Attachment A - Flow Chart for creation / elaboration of Interface Coordination Sheet

Attachment B – Flow Chart for Progress Monitoring of Interface Agreements

Attachment C – Interface Specification Form.

Attachment D – Indicative Interface sheets

Attachment E – Master Interface Matrix

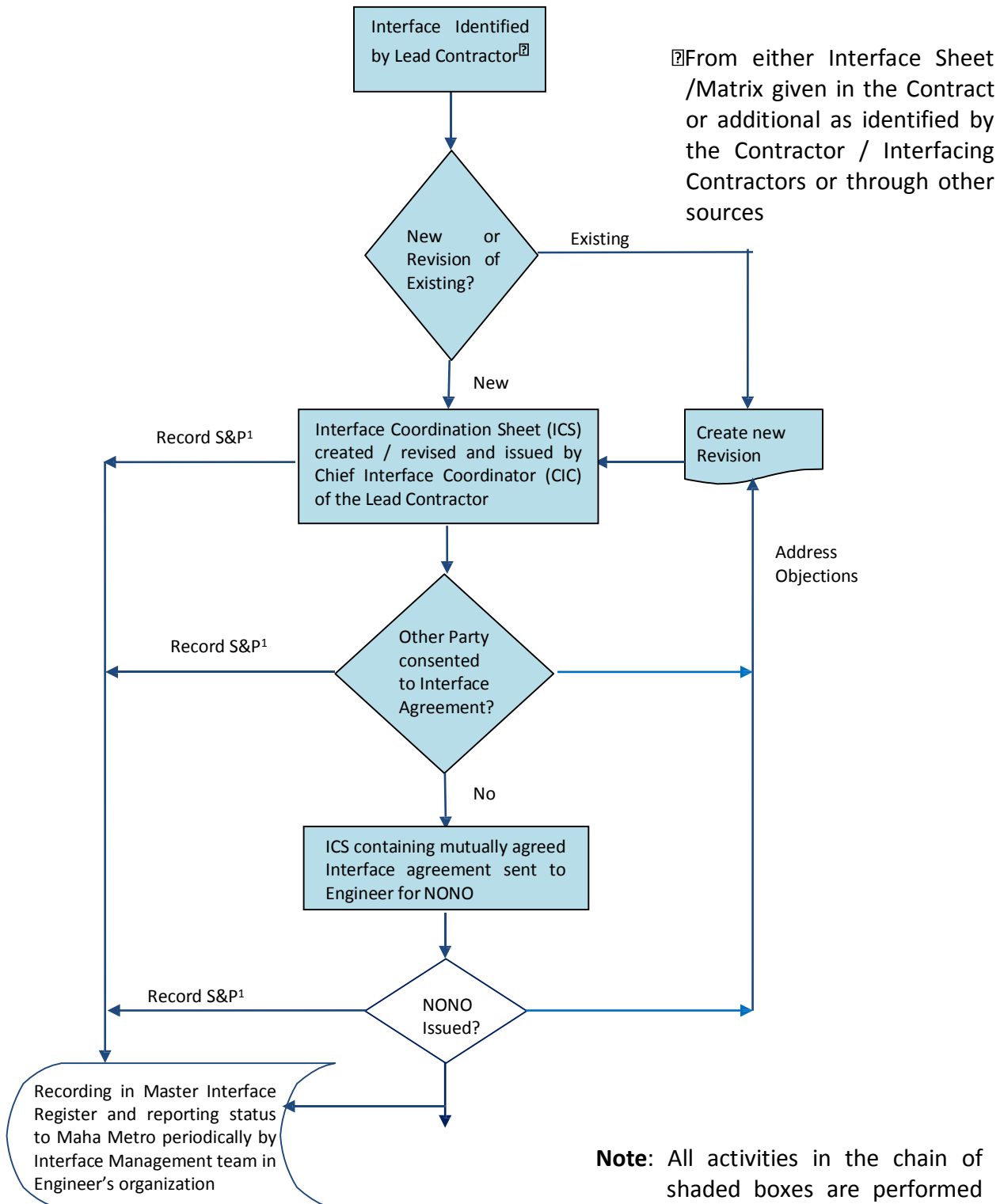
Attachment F – Interface Coordination Sheet

Attachment G – Confirmation of Co-ordination Form

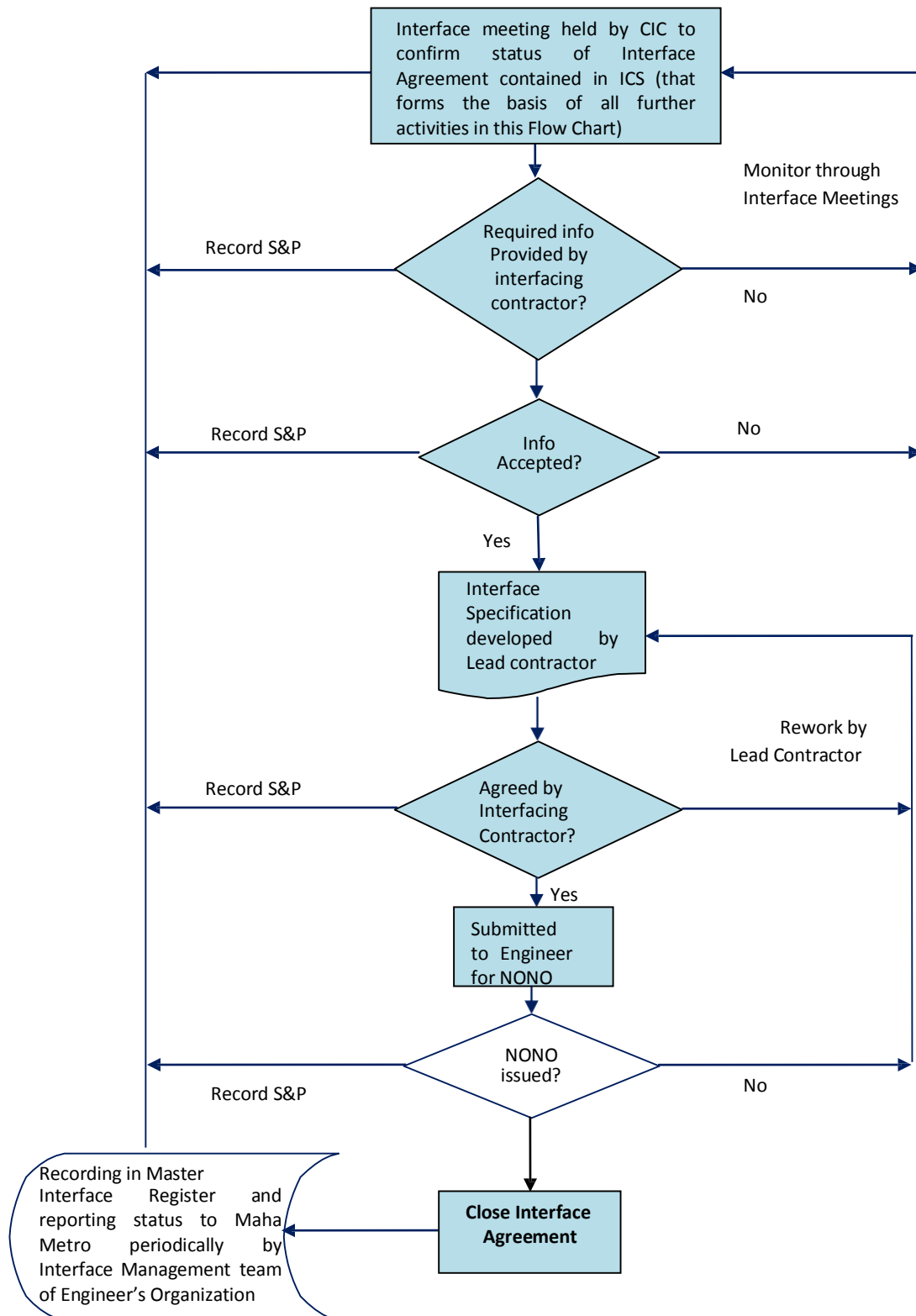
Attachment H - Guidance Notes for the Preparation of IMPG

Attachment I – Guidance Notes for the Preparation of IMP

Attachment A Flow Chart for creation / elaboration of Interface Coordination Sheet



Attachment B Flow Chart for Progress Monitoring of Interface Agreements



Note: All activities in the chain of shaded boxes are performed by Contractors, duly overseen by Engineer.

Attachment C - Interface Specification Form

INTERFACE SPECIFICATION	Ref:
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	Contract Designation	Contractors Sequence Number	Date of Issue	
Initiating Contracto			Interface Manager	
Responding Contractor			Interface Manager	
Interface Specification Required			Response Required by;	
Reviewed by;				
Design Sections	Civil Work	Track work	Station Arch. / Building Services	Core Systems
<u>Description of the Interface</u>				
<u>Specific Details of the Interface</u>				<u>Location</u>
Drawings / Specifications Attached				
Title	Drawing / Specification Ref.		Drg. Issue	
Document	Name	Date	Document References (if any)	
Prepared by:				

Attachment D – Indicative Interface Sheets

List of Interface sheet for UGC-02

SL NO	Description
1	UGC-01 (Tunnel) vs. UGC-02 Station
2	TVS&VAC(ECS) vs. Civil UG Stations & Tunnel (UGC-02)
3	Lifts & Escalators vs. Civil UG Stations (UGC-02)
4	Rolling Stock vs. Civil UG Stations & Tunnel (UGC-02)
5	Track vs. Civil UG Stations (UGC-02)
6	Track vs. Civil UG Tunnel (UGC-02)
7	Power Supply System vs. Civil UG Stations & Tunnel (UGC-02)
8	OHE vs. Civil UG Stations (UGC-02)
9	OHE vs. Civil UG Tunnel (UGC-02)
10	S&T vs. Civil UG Stations (UGC-02)
11	S&T vs. Civil UG Tunnel (UGC-02)
12	PSD vs. Civil UG Stations (UGC-02)
13	AFC vs. Civil UG Stations (UGC-02)

1. UG Tunnel (UGC-01) and UG Station (UGC-02)

Contract A : UG Tunnel (UGC-01) (Interface Lead)		Contract B : UG Station (UGC-02) (Interface follower)	Sheet # : 1/3
Contract A (UGC-01 - Tunnel)	DESIGN STAGE	Contract-B (UGC-02 –Station)	
<p>UT/US-01: Contractor-A shall provide to the Contractor-B all the details and parameters necessary for the provision of soft-eye in the Diaphragm wall/secant pile wall/tunnel face of Budhwar Peth station.</p> <p>UT/US-02: Contractor-A shall design any ground improvement/ treatment required outside the station wall/tunnel face depending upon his chosen tunneling scheme in consultation with Contractor-B duly interfacing and sharing the required information/details with him.</p> <p>UT/US-03: Contractor-A shall agree Survey and Alignment with Contractor-B</p>		<p>UT/US-01: Contractor-B shall provide the required soft-eye in the Diaphragm wall/secant pile wall/tunnel face of Budhwar Peth station duly ensuring the overall compatibility with the Station design.</p> <p>UT/US-02: Contract-B shall Design station walls/tunnel face to be compatible with the tunneling scheme and arrangements including any ground treatment of the Contractor-A. Contractor-A TBMs in the Civil Court station .</p> <p>UT/US-03: Contractor-B shall agree Survey and Alignment with Contractor-A</p>	

Contract A : UG Tunnel (UGC-01) (Interface Lead)		Contract B : UG Station (UGC-02) (Interface follower)	Sheet # : 2/3
<p>UT/US-04: Contractor-A shall design temporary and permanent drainage system in consultation with contractor-B</p> <p>UT/US-05: (a) Contractor-A shall design and install electrical services like emergency light, fire detection linear cable etc., from half of tunnel and extend them up to the termination points inside the Budhwar Peth station, (b) Contractor-A shall design and install fire hydrant, plumbing services, etc., upto the boundary line of the two Contracts.</p>		<p>UT/US-04: Contractor-B shall plan and design drainage system in consultation with contractor-A</p> <p>UT/US-05: (a) Contractor-B shall provide cable tray for Contractor-A requirements from the common contract boundary point upto the termination points and design the electrical system for emergency light and fire detection etc., (b) Contractor-B shall design and install fire hydrant, plumbing services, etc., to suit the contractor-A design and tap it from the Contract boundary line.</p>	
Contract A (UGC-01 - Tunnel)	CONSTRUCTION / INSTALLATION STAGE	Contract-B (UGC-02 –Station)	
<p>UT/US-06: Contractor-A shall Provide TBM programme/Access Schedule, land sharing schedule , construction programme and actual Physical progress</p> <p>UT/US-07: Contractor-A shall carry out any ground improvement/ treatment work required outside the station wall/tunnel face depending upon his chosen tunneling scheme in consultation with Contractor-B duly interfacing and sharing the required information/details with him.</p> <p>UT/US-08: (a) Contractor-A shall install tunnel electrical systems/services cables up to the Distribution boards/terminal points inside the Budhwar Peth Station (b) Contractor-A shall terminate fire hydrant system, drainage system etc. at Contract boundary point</p> <p>UT/US-09: Contractor-A shall construct temporary and permanent drainage system and interlink with Contractor–B drainage system</p>		<p>UT/US-06: Contractor-B shall Review & follow TBM programme and shall provide space for TBM break-through and retrieval from Station central portion and drainage systems .</p> <p>UT/US-07: Contractor-B shall Provide space and access to Contractor-A (tunnel Contractor), inside/outside the station, as required, for carrying out the ground treatment works.</p> <p>UT/US-08: (a) Contractor-B shall install/provide cable tray meeting the requirements of Contractor-A, from Contract boundary point upto the termination points and provide proper terminal points to connect tunnel side electrical cables (b) Contract-B shall tap fire hydrant system, drainage system etc. from the Contract boundary point</p> <p>UT/US-09 : Contractor-B shall construct temporary and permanent drainage system and interlink with Contractor-A drainage system</p>	

Contract A : UG Tunnel (UGC-01) (Interface Lead)		Contract B : UG Station (UGC-02) (Interface follower)	Sheet # : 3/3
<p>UT/US-10: Contractor-A shall Install cradle for receiving the TBMs</p> <p>UT/US-11: Contractor-A shall Breakthrough soft-eyes with TBMs</p> <p>UT/US-12: Contractor-A shall Dismantle and remove TBMs from the station central portion</p> <p>UT/US-13: Contractor-A shall provide proper sealing in the tunnel eye (if found necessary)</p> <p>UT/US-14: Contractor-A shall Request water stoppage barrier to prevent water entry from UGC-02 to UGC-01 area</p>		<p>UT/US-10: Contractor-B shall clear the area and provide the space for cradle</p> <p>UT/US-11: Contractor-B shall Construct soft-eyes in Station wall/tunnel face to accept two TBMs</p> <p>UT/US-12: Contractor-B shall Allow Contractor-A for the breakthrough & removal of TBMs from station central portion</p> <p>UT/US-13: Contractor-B shall Jointly inspect and accept the sealing</p> <p>UT/US-14: Contractor-B shall Install water stoppage barrier to prevent water entry from UGC-02 to UGC-01 area</p>	
Contract A (UGC-01 - Tunnel)	TEST & COMMISSIONING STAGE		Contract-B (UGC-02 –Station)
<p>UT/US-15: Alignment of the tunnels and 1st stage concrete in the tunnels to match the arrangement/level with respect to the station/tunnel base slab</p> <p>UT/US-16: Stop water leakage between the station wall/NATM tunnel face & bored tunnels</p>		<p>UT/US-15: Agree and accept</p> <p>UT/US-16: Joint inspection and accept</p>	
Tunnel 1 st Stage			

2. Tunnel Ventilation & UG Station Air Conditioning System (TVS and ECS) and UG Stations & Tunnel (UGC-02)

Contract A : Tunnel Ventilation & UG Station Air Conditioning System (Interface Lead)		Contract B : UG Stations & Tunnel (UGC-02) (Interface follower)	Sheet # : 1/7
Contract A (TVS and ECS)	DESIGN STAGE	Contract B (UG-Stations & Tunnel)	
Interface related to Architectural:			
TV/UG-01: Contractor A shall collect station Architectural/Structural drawings including room names, location of rooms and sectional views in the concourse level, mezzanine level (where applicable), platform level and street level including subways and shafts etc.,		TV/UG-01: Contractor B shall provide the same as requested by contractor A.	
TV/UG-02: Shall provide the room size, door size, shaft & Plenum size and finish details for all VAC (ECS) and Tunnel ventilation (TVS) equipmentsystems.		TV/UG-02: Shall incorporate the same in the station design.	
TV/UG-03: Shall collect all corridor and door details to facilitate equipment delivery in the station ancillary areas, VAC(ECS) and Tunnel ventilation (TVS) equipment rooms etc. and request for any changes/modifications, if required,		TV/UG-03: Shall provide all corridor and door details as requested by contractor A and incorporate the changes as per the requirements of Contractor-A.	
TV/UG-04: Shall collect the details of walls, ceiling, floor, windows and finish details to design VAC (ECS) system.		TV/UG-04: Shall provide the same as requested by contractor A.	
TV/UG-05: Shall provide size to get space and location of VAC concrete shaft and Tunnel ventilation concrete shaft as well as adjust the location of shaft.		TV/UG-05: Shall incorporate the same in the station design and provide the suitable shaft locations.	
TV/UG-05(A): Shall provide the required design details (such as spacing, free area required, material, various dimensions and clearances etc.) of the External Intake and Outlet Louvers for the TVS and ECS shafts to Contractor B.		TV/UG-05(A): Shall Design the External Intake and Outlet Louvers for the TVS and ECS shafts and incorporate the same in the station design duly considering the site- specific architectural and finishing requirements and fulfilling the design requirements provided by Contractor A.	
TV/UG-06: Shall provide size to get space and location of concrete shaft for condensed water pipes from cooling tower to chiller plant room as well as adjust the location of shaft.		TV/UG-06: Shall incorporate the same in the station design and provide the suitable shaft location.	
TV/UG-07: Shall provide size to get space and location of concrete shaft for chilled water pipes from chiller plant room to Air handling units as well as adjust the location of shaft.		TV/UG-07: Shall incorporate the same in the station design and provide suitable shaft location.	

Contract A : Tunnel Ventilation & UG Station Air Conditioning System (Interface Lead)	Contract B : UG Stations & Tunnel (UGC-02) (Interface follower)	Sheet # : 2/7
<p>TV/UG-08: Shall collect opening size, location details, and cross sectional views of all staircases including emergency staircase to design staircase pressurisation system.</p> <p>TV/UG-09: Shall collect details of smoke protection zone to design smoke extract fan and fire limit zone for evacuation of people.</p> <p>TV/UG-10: Shall provide size to get space and location of concrete duct for under platform exhaust and over track way exhaust system.</p> <p>TV/UG-10A: Shall provide details of fire rated door size and location in the tunnel ventilation concrete shaft in the TVS equipment room</p> <p><u>Interface related to Civil:</u></p> <p>TV/UG-11: Shall provide size and location details to make pedestal for VAC(ECS) equipment and Tunnel ventilation equipment (TVS); such as Air handling units, Fans and Outdoor units for Split air conditioning etc.,</p> <p>TV/UG-12: Shall provide size and location details to make pedestal for chiller plant room equipment.</p> <p>TV/UG-13: Shall provide size and location details to make pedestal for cooling tower plant equipment.</p> <p>TV/UG-14: Shall provide size and location details to make pedestal for condenser water and chilled water pipes.</p> <p>TV/UG-15: Shall provide duct size and duct routing to make opening in the wall/ceiling/slabs as well as get the space for ducting.</p> <p>TV/UG-16: Shall provide pipe size and pipe routing to make opening in the wall/ceiling/slabs as well as get the space for piping.</p>	<p>TV/UG-08: Shall provide the same to design VAC (ECS) system.</p> <p>TV/UG-09: Shall provide the detailed drawing to design VAC (ECS) system.</p> <p>TV/UG-10: Shall incorporate the same in the station design.</p> <p>TV/UG-10A: Shall incorporate contractor-A requirements in TVS equipment room</p> <p>TV/UG-11: Shall design the pedestal for VAC (ECS) equipment and Tunnel ventilation (TVS) equipment to accommodate the details by Contractor-A.</p> <p>TV/UG-12: Shall design the pedestal for chiller plant room equipment to accommodate the details by Contractor-A.</p> <p>TV/UG-13: Shall design pedestal or foundation for cooling tower plant equipment to accommodate the details by Contractor-A.</p> <p>TV/UG-14: Shall design the pedestal for condensed water and chilled water pipes to accommodate the details by Contractor-A.</p> <p>TV/UG-15: Shall provide coordinated combined builders work drawing agree jointly and provide opening in wall/ ceilings/slabs for duct route.</p> <p>TV/UG-16: Shall provide coordinated combined builders work drawing agree jointly and provide opening in wall/ ceilings/slabs for pipe route.</p>	

Contract A : Tunnel Ventilation & UG Station Air Conditioning System (Interface Lead)	Contract B : UG Stations & Tunnel (UGC-02) (Interface follower)	Sheet # : 3/7
<p>TV/UG-17: Shall provide cabling size and cable routing to make opening in the wall/ceiling/slabs and get the space for cabling including cable tray and brackets etc.</p> <p>TV/UG-18: Shall give opening size and location in the false ceiling to mount grille and dampers.</p> <p>TV/UG-19: Shall give size and location to make concrete shaft for chilled water pipe line from chiller plant room to Air handling unit.</p> <p>TV/UG-20: Shall give size and location to make concrete shaft for condensed water pipe line from cooling tower to chiller plant rooms.</p> <p>TV/UG-21: Shall give size and location to make concrete shaft for VAC system (ECS) and Tunnel ventilation system (TVS). Water proofing required in the concrete shaft.</p> <p>TV/UG-21(A): Shall give the requirements and details of the External Intake and Outlet Louvers for the TVS and ECS shafts to Contractor B.</p> <p>TV/UG-22: Shall provide size and location of pipe/cable to fix sleeves.</p> <p>TV/UG-23: Shall provide size and location to make opening in the wall/ceiling/slabs to carry VAC system equipment and Tunnel ventilation system equipment from one level to another level.</p> <p>TV/UG-24: Shall give size and location details to get space for mounting fan coil units and split air conditioning units in the station ancillary/plant rooms.</p> <p>TV/UG-25: Shall provide size and location to make opening in the wall to provide air louver and ventilation fans in the station ancillary/plant rooms and electrical rooms.</p>	<p>TV/UG-17: Shall provide coordinated combined builders work drawing agree jointly and provide opening in wall/ ceilings/slabs for cable route and provide the space for cabling including cable tray and brackets etc.</p> <p>TV/UG-18: Shall provide openings in false ceiling to mount grilles and dampers</p> <p>TV/UG-19: Shall accommodate the details given by contractor-A in making concrete shaft.</p> <p>TV/UG-20: Shall accommodate the details given by contractor-A in making concrete shaft.</p> <p>TV/UG-21: Shall accommodate the details given by contractor-A in making concrete shaft.</p> <p>TV/UG-21(A): Shall provide/construct the External Intake and Outlet Louvers for the TVS and ECS shafts as per the requirements and details provided by Contractor A.</p> <p>TV/UG-22: Shall provide coordinated combined builders work drawing agree jointly and accommodate the sleeves for pipe/cable</p> <p>TV/UG-23: Shall accommodate the size and location of opening in the wall/ceiling/slabs to carry VAC system equipment and Tunnel ventilation system equipment from one level to another level.</p> <p>TV/UG-24: Shall provide space to accommodate them in station ancillary/plant rooms.</p> <p>TV/UG-25: Shall make opening in the wall to accommodate them in station ancillary/plant rooms and electrical rooms.</p>	

Contract A : Tunnel Ventilation & UG Station Air Conditioning System (Interface Lead)	Contract B : UG Stations & Tunnel (UGC-02) (Interface follower)	Sheet # : 4/7
<p>TV/UG-26: Shall provide number of openings, opening size and location details in the concrete duct for under platform exhaust and over track way exhaust system.</p> <p>TV/UG-27: Shall get the space to fix air curtains in the station entrances (including subways entrances) to prevent conditioned air loss from concourse public areas.</p> <p><u>Interface related to Plumbing:</u></p> <p>TV/UG-28: Shall collect drain point in the VAC (ECS) equipment rooms, chiller plant room, Cooling tower plant and Tunnel ventilation equipment rooms etc.,</p> <p>TV/UG-29: Shall collect drain point for all fan coil units and its associated pipes in the station ancillary areas.</p> <p>TV/UG-30: Shall collect water supply pipe line connection and other accessories from plumbing centre to the makeup water tank. Shall provide water requirements for cooling tower system.</p> <p>TV/UG-31: Shall collect water supply pipe line connection, floor drain with grating for VAC equipment rooms, chiller plant room and Tunnel ventilation equipment rooms etc.,</p>	<p>TV/UG-26: Shall accommodate them.</p> <p>TV/UG-27: Shall provide the space to fix air curtains in the station entrances (including subways entrances) to Prevent conditioned air loss from concourse public areas</p> <p>TV/UG-28: Shall provide through plant room floor drains.</p> <p>TV/UG-29: Shall provide through floor drains in the nearby wet area. (Janitors closet / Refuse room / Cleaners room / Lunch room / Toilet / Mechanical equipment room, etc.)</p> <p>TV/UG-30: Shall provide one point of connection up to cooling tower Make up water tank.</p> <p>TV/UG-31: Shall provide Water supply through one point of connection and floor drain through plant room floor drains.</p>	
<p><u>Interface related to Electrical (Low Voltage Distribution):</u></p> <p>TV/UG-32: Shall collect the details of equipment heat generation load, number of persons and operating temperature details in the electrical rooms such as DG room and UPS room etc. to design VAC system.</p> <p>TV/UG-33: Shall collect the details of lighting heat generation load in the station (public and non-public areas including subways etc.) to design VAC system.</p>	<p>TV/UG-32: Shall provide the details as requested by contractor A.</p> <p>TV/UG-33: Shall provide the details of lighting heat generation load.</p>	

Contract A : Tunnel Ventilation & UG Station Air Conditioning System (Interface Lead)	Contract B : UG Stations & Tunnel (UGC-02) (Interface follower)	Sheet # : 5/7
<p>TV/UG-34: Shall coordinate for power requirements (Normal ,DG, & UPS) for complete Station and Tunnel loads to design the main switchboards in the ASS room.. Shall provide the location and power requirements for the TVS and VAC electric panels considering all modes to enable UGC-01 contractor to plan for distribution and sizing the DG and UPS.</p> <p>TV/UG-35(A): Shall get the cable containment for VAC and tunnel ventilation system upto inner wall of VAC and TVS panel rooms.</p> <p>TV/UG-35(B): Shall get the earth bus in the VAC and tunnel ventilation system equipment rooms</p> <p><u>Interface related to Fire Detection System:</u></p> <p>TV/UG-36: Shall collect the details of fire heat generation capacity (Fire load) in the station areas <u>(and subways' etc.)</u> to design smoke exhaust fan capacity.</p> <p>TV/UG-37: Shall provide cabling up to Interface terminal board/Interface unit to get control signal from fire alarm main panel to Smoke Control Panel/Motor control centre via SCADA for the operation of smoke extract fan, Track way exhaust system and Tunnel ventilation system during a fire in station, tunnel and cross over. Shall provide VAC system and Tunnel ventilation system functions for fire in station, tunnel and crossover in the operation mode table for comply with compatibility.</p>	<p>TV/UG-34: Shall coordinate for power requirements (Normal, DG & UPS) the three phase and single phase including fault levels etc. for the power loads in station and tunnel, to enable TVS/ECS contractor to design and supply the main switchboards in the ASS room. Shall check the location of <u>Outgoing feeders from</u> main distribution boards to design the further distribution.</p> <p>TV/UG-35(A): Shall provide the cable containment for VAC and tunnel ventilation system upto inner wall of VAC and TVS panel rooms.</p> <p>TV/UG-35(B): Shall provide the earth bus in the VAC and tunnel ventilation system equipment rooms</p> <p>TV/UG-36: Shall provide the details as requested by contractor A.</p> <p>TV/UG-37: Shall provide the Provision through Interface terminal board/Interface unit/Control module/Monitor module etc.</p>	

Interface related to Tunnel:			
TV/UG-37(A): Shall provide the details of pressure effects on cross passage doors in the tunnel induced by train piston effect.		TV/UG-37(A): Shall get the details of pressure effects on cross passage doors in the tunnel induced by train piston effect.	
Contract A(Tunnel Ventilation & Station VAC)	CONSTRUCTION / INSTALLATION STAGE	Contract B(UG-Station&Tunnel)	
Interface related to Architectural:			
TV/UG-38: Contractor A shall check room sizes, stair case sizes, door sizes and finishes for VAC and Tunnel ventilation system as provided by contractor B.		TV/UG-38: Shall Co-ordinate with contractor –A	
Contract A : Tunnel Ventilation & UG Station Air Conditioning System (Interface Lead)		Contract B : UG Stations & Tunnel (UGC-02) (Interface follower)	Sheet # : 6/7
Interface related to Civil:			
TV/UG-39: Shall check all pedestals for VAC and Tunnel ventilation system equipment as provided by contractor B.		TV/UG-39: Shall Co-ordinate with contractor –A	
TV/UG-40: Shall check all concrete shafts <u>(including Intake and Outlet external Louvers)</u> for VAC and Tunnel ventilation system.		TV/UG-40: Shall Co-ordinate with contractor –A	
TV/UG-41: Shall check all concrete ducts for VAC and Tunnel ventilation system.		TV/UG-41: Shall Co-ordinate with contractor –A	
TV/UG-42: Shall check the space and all opening dimensions in the Wall/ceiling/slabs to run ducting, piping and cabling.		TV/UG-42: Shall Co-ordinate with contractor -A	
TV/UG-43: Shall check all opening dimensions in the false ceiling to mount grilles and dampers.		TV/UG-43: Shall Co-ordinate with contractor –A	
TV/UG-44: Shall check opening dimensions in the wall/ceiling/slabs to carry VAC and Tunnel ventilation equipment.		TV/UG-44: Shall Co-ordinate with contractor -A	

<p>TV/UG-45: Shall check the space to mount fan coil units and split air conditioning units.</p> <p>TV/UG-46: Shall check the sleeves for pipe/cables.</p> <p>TV/UG-47: Shall check opening sizes in the wall to provide air louver and ventilation fans in the station ancillary/plant areas and electrical rooms.</p> <p>TV/UG-48: Shall check number of openings, opening size in the concrete duct for under platform exhaust and over track way exhaust system.</p>	<p>TV/UG-45: Shall Co-ordinate with contractor -A</p> <p>TV/UG-46: Shall Co-ordinate with contractor -A</p> <p>TV/UG-47: Shall Co-ordinate with contractor –A</p> <p>TV/UG-48: Shall Co-ordinate with contractor –A</p>
<p>Contract A : Tunnel Ventilation & UG Station Air Conditioning System (Interface Lead)</p>	<p>Contract B : UG Stations & Tunnel (UGC-02) (Interface follower)</p> <p style="text-align: right;">Sheet # : 7/7</p>
<p><u>Interface related to plumbing:</u></p> <p>TV/UG-49: Shall check all the drain point, grating for the floor drain and connection for water supply for VAC and Tunnel ventilation system as provided by contractor B.</p> <p><u>Interface related to Electrical (Low Voltage Distribution):</u></p> <p>TV/UG-50: Shall check three phase and single phase incoming power supply for normal, congested and emergency operation for all VAC and Tunnel ventilation system equipment.</p> <p>TV/UG-50(A): Shall check the cable containment works.</p> <p><u>Interface related to Fire Detection system:</u></p> <p>TV/UG-51: Shall check cabling in the Interface terminal board/Interface unit to get control signal from fire alarm main panel to Smoke Control Panel/Motor control centre via SCADA for the operation of smoke extract fan, Track way exhaust system and Tunnel ventilation system during a fire in station, tunnel and cross over.</p>	<p>TV/UG-49: Shall Co-ordinate with contractor –A</p> <p>TV/UG-50: Shall Co-ordinate with contractor –A and shall check the location of all main/emergency LV switchboards in ASS room for further distribution.</p> <p>TV/UG-50(A): Shall Co-ordinate with contractor –A</p> <p>TV/UG-51: Shall Co-ordinate with contractor -A</p>

Contract A(TVS and ECS)	TEST & COMMISSIONING STAGE	Contract B(UG-Station&Tunnel)
<u>Interface related to Electrical (Low Voltage Distribution):</u> TV/UG-52: Shall conduct joint testing on the electrical inputs and outputs operation required for VAC (ECS) and TV system (TVS).		TV/UG-52: Shall agree and do the needful.
Contract A(TVS AND ECS)	MAINTENANCE STAGE	Contract B(UG-Station&Tunnel)
TV/UG-53: Shall jointly agree and accept as per the maintenance specification		TV/UG-53: Shall do the needful as per the maintenance specification of the station and tunnel.

3. Lifts and Escalators and UG Stations & Tunnel (UGC-02)

Contract A : Lifts and Escalators (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 1/2
Contract A (Lifts & Escalators)	DESIGN STAGE	Contract B (UG station)	
LE/US-01: Shall provide the requirements of total Electrical Power (Normal, DG and UPS), Earthing, Cable Routing & location of the power point (Isolator) for Lifts and Escalators in the station.		LE/US-01: Shall collect the load details and give input to power supply (PST) contractor to select the capacity of Transformer (ASS). Shall design the earthing (from earth pit to respective equipment room), Cable routing and isolators locations as per the requirements.	
LE/ES-02: (a) Shall provide the interface details of Fire alarm system inside the lift & firefighting system inside the escalator to Contractor-B. (b) Shall implement functional requirements in software		LE/ES-02: (a) Shall collect the details from Contractor-A and utilize the input for fire protection/Alarm system (b) Shall provide functional requirements under various emergency conditions	
LE/US-03: Shall provide the requirement of mounting and structural details like head room space, lift shaft spacing, lift pit (water resistant), Escalator pits (water resistant), with notches and gravitational drainage system to Contractor-B		LE/US-03: Shall incorporate Contractor-A’s requirements in his station design.	
LE/US-04: Shall request access (to site) and delivery space for Lifts and Escalators		LE/US-04: Shall incorporate Contractor-A’s requirement in his station design.	
LE/US-05: Shall request the station architectural/structural drawings		LE/US-05: Shall provide the station architectural/structural drawings.	
LE/US-06: Shall provide the architectural/structural/fixing ‘general arrangement drawing’ of Lifts and Escalators for installation with load details.		LE/US-06: Shall incorporate Contractor-A’s requirement in his station design.	
LE/ES-06A: Shall provide interface details of sprinkler system inside Escalator to Contractor-B		LE/ES-06A: Shall collect details from Contractor-A to provide water tap at suitable location and design his system accordingly	
Contract A (Lifts & Escalators)	CONSTRUCTION / INSTALLATION STAGE	Contract B (UG station)	
LE/US-07: Shall jointly check the availability of requirement (shaft/site, readiness) for Lifts and Escalators installation, like Power Supply, Earthing Cable routing, power supply Isolator points, mounting facility, water resistant pits, access and delivery space as per the drawing (provided by Lift & Escalator Contractor) suitable for lifts & Escalators erection and confirm.		LE/US-07: Shall provide ‘Contractor A’ requirements in station.	

Contract A : Lifts and Escalators (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 2/2
<p>LE/US-08: Shall request free space for temporary storage in the Station building.</p> <p>LE/US-09: Space should be free from human interference materials.</p> <p>LE/US-10: Shall request Contractor-B for Lift entrance cladding (Architrave).</p> <p>LE/US-11: Shall provide the safety working atmosphere at work site.</p> <p>LE/US-12: Shall provide the micro schedule of erection.</p> <p>LE/US-13: Shall request water connection to Escalator sprinkler system.</p>		<p>LE/US-08: Shall provide free space for the temporary storage for limited period.</p> <p>LE/US-09: Will ensure the space is free from human interference materials</p> <p>LE/US-10: Shall provide Lift entrance cladding (Architrave).</p> <p>LE/US-11: Shall request the safety working atmosphere at work site.</p> <p>LE/US-12: Shall request the micro schedule of erection before erection starts.</p> <p>LE/US-13: Shall provide the water connection as per the requirements of Contractor-A.</p>	
Contract A (Lifts & Escalators)	TEST & COMMISSIONING STAGE	Contract B (UG station)	
LE/US-14: Contract-A Shall Conduct test run jointly with Contractor-B		LE/US-14: Contractor-B shall co-ordinate with Contractor - A.	
Contract A (Lifts & Escalators)	MAINTENANCE STAGE	Contract B (UG station)	
LE/US-15: As per the maintenance manual supplied by supplier and agreed by all the parties.		LE/US-15: As per the maintenance manual supplied by supplier and agreed by all the parties	

4. UG Stations & Tunnel (UGC-02) and Rolling Stock

Contract B : UG Stations & Tunnel (UGC-02) (Interface follower)		Contract B : Rolling Stock (Interface follower)	Sheet # : 1/2
Contract A(UG Station & Tunnel)	DESIGN STAGE	Contract B (Rolling stock)	
Tunnel: TL/RS-01: (a) Contractor-A shall give the details of Tunnel Design Drawings showing the indicative curves, dimensional clearances, gradients, chainages, levels to rolling stock contractor(Contractor-B) (b) Shall obtain from the Contractor-B, the values of maximum attainable speed on each curve in normal and all-out modes (based on simulation studies to be done by the Contractor-B) so as to determine the values of cant to be provided on each curve to determine the design/theoretical coordinates of tunnel center on each curve. (c) Shall obtain from the Contractor-B the Rolling Stock details such as length of train cars, height and location of doors, loading configuration (axle loads and configurations) etc. for tunnel and walkway design. TL/RS-02: Contractor-A Shall give details of the emergency escape provision in tunnels to Contractor-B TL/RS-03: In tunnel, maximum flood level (water height) will be 100 mm –car must still operate UG-Station: TL/RS-04: Contractor-A shall obtain the details of Rolling stock including length of train cars, height , throws on curves, platform clearances to be maintained on straight and curved tracks, loading configuration(axle loads and configurations) etc. for station design.		TL/RS-01: (a) Contractor-B shall obtain the details of Tunnel Design Drawings showing the indicative curves, dimensional clearances, gradients, chainages, levels to design rolling stock suitably (b) Shall provide the required details to Contractor-A (c) Shall provide the required details to Contractor-A TL/RS-02: Contractor-B shall design the rolling stock with suitable emergency escape provision to match tunnel provision TL/RS-03: Contractor-B shall design under slung equipment suitably TL/RS-04: Contractor-B shall give the required details to Contractor-A	

Contract B : UG Stations & Tunnel (UGC-02) (Interface follower)		Contract B : Rolling Stock (Interface follower)	Sheet # : 2/2
TL/RS-05: Contractor-A shall require the details of kinematic, structural gauges and swept envelope on straight and curved tracks		TL/RS-05: Contractor-B shall give the details of kinematic, structural gauges and swept envelope for straight and curved tracks.	
Contract A(UG Station & Tunnel)	CONSTRUCTION / INSTALLATION STAGE	Contract B (Rolling stock)	
TL/RS-06: Shall jointly check and confirm the curves, dimensional clearances, gradients, chainages, levels and emergency escape provision		TL/RS-06: Shall co-ordinate and confirm with contractor-A	
TL/RS-07: Contractor-A shall participate/attend test run and do modifications, if required.		TL/RS-07: Contract-B shall be required to conduct test run with the train at low speed.	
Contract A(UG Station & Tunnel)	TEST & COMMISSIONING STAGE	Contract B (Rolling stock)	
TL/RS-08: Shall jointly check and confirm the maximum noise/echo level with Respect to various operating speeds of rolling stock.		TL/RS-08: Shall co-ordinate and confirm with contractor-A	
TL/RS-09: Contractor-A shall coordinate with contractor-B to complete testing and commissioning work		TL/RS-09: Contractor-B shall be required to conduct integrated tests with all systems	
Contract A(UG Station & Tunnel)	MAINTENANCE STAGE	Contract B (Rolling stock)	
NIL		NIL	

5. Track and UG Stations (UGC-02)

Contract A: Track (Interface Lead)		Contract B : UG Stations (UGC-02) (Interface follower)	Sheet # : 1/2
Contract A(TRACK)	DESIGN STAGE	Contract B(UG-Station)	
<p>TK/UG-01: Shall fix chainages of the Turnouts / Cross over based on the chainage of Station Centre Line furnished by the Contractor-B.</p> <p>TK/UG-02: Shall ensure at design stage.</p> <p>TK/UG-03: Shall provide Track drainage consistent with the General Drainage arrangement in Station area and agree & provide the Point of interface</p>		<p>TK/UG-01: Shall furnish correct chainage of Station centre line to Contractor-A.</p> <p>TK/UG-02: Shall ensure that the pillars / columns supporting the station structure and all other structures are located clear of the minimum infringement clearances from centre of track as stipulated in the approved S.O.D.</p> <p>TK/UG-03: Shall design the General drainage system (overall drainage system) in the Station area taking into account Track Drainage and accept the Point of Interface in the Station/Platform Area.</p>	
Contract A(TRACK)	CONSTRUCTION / INSTALLATION STAGE	Contract B(UG-Station)	
<p>TK/UG-04: Shall arrange for taking over after joint verification with Contractor-B</p> <p>TK/UG-05: Shall ensure before taking up track installation work.</p>		<p>TK/UG-04: Shall hand over to the Track contractor(Contractor-A) the concrete base (duly providing 1st pour concrete, if required, and the shear connectors for track laying within the permitted tolerances) for track structure and the station platform to designated levels / clearances with in the tolerances permitted.</p> <p>TK/UG-05: Shall hand over the track installation area in the vicinity of Pillars / Columns and such structures/obstructions clear of the infringement distances stipulated in the approved S.O.D.</p>	

Contract A: Track (Interface Lead)		Contract B : UG Stations (UGC-02) (Interface follower)	Sheet # : 2/2
<p>TK/UG-06: Shall jointly decide with the Contractor-B opening requirements, storage spaces and Schedule of Access Periods and ensure implementation based on track construction program.</p> <p>TK/UG-07: Shall furnish details of requirements to Contractor-B.</p> <p>TK/UG-08: To check the levels of platform and track base concrete at the time of taking over from Contractor-B and ensure that the heights and clearances from rail level / centre of track are within acceptable limits as per the approved S.O.D.</p>		<p>TK/UG-06: Shall provide the required openings in the structures to lower the track materials/plants/equipment including rails for track construction and provide storage space for Track materials in consultation with Track contractor (Contractor-A) and shall permit Access to Track contractor for construction of Track as per agreed Schedule of Access Periods.</p> <p>TK/UG-07: Shall provide Temporary water supplies for construction of Track. Shall design & construct the water supply scheme in consultation with Track Contractor.</p> <p>TK/UG-08: Shall ensure that levels of Platform and Track Base Concrete in Station Boxes conform to the Design Levels and Tolerances. Shall furnish completed levels, curvature & cant, if any, to Track Contractor (Contractor-A) for any adjustment in rail level/alignment while laying Track.</p>	
Contract A(TRACK)	TEST & COMMISSIONING STAGE	Contract B(UG-Station)	
<p>TK/UG-09: Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the approved S.O.D</p>		<p>TK/UG-09: Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the approved S.O.D</p>	
Contract A(TRACK)	MAINTENANCE STAGE	Contract B(UG-Station)	
NIL		NIL	

6. Track and UG Tunnel (UGC-02)

Contract A: Track (Interface Lead)		Contract B : UG Tunnels UGC-02 (Interface follower)	Sheet # : 1/2
Contract A (TRACK)	DESIGN STAGE	Contract B (UG-TUNNEL)	
TK/UG-01: Shall provide for Track Drainage system design consistent with the general drainage arrangements in the Tunnel and agree & provide the Point of interface in the cross passage / track sump.		TK/UG-01: Shall design the general drainage system in the Tunnel taking into account Track Drainage and accept the Point of Interface in the cross passage/track sump.	
Contract A (TRACK)	CONSTRUCTION / INSTALLATION STAGE	Contract B (UG-TUNNEL)	
TK/UG-02: Shall arrange for taking over after joint verification with Contractor-B and take up construction of the 2nd Pour concrete in the track above the 1st pour concrete done utilising the provisions of keying / shear connectors done by the Tunnel contractor (Contractor-B)		TK/UG-02: Shall complete construction of the 1st pour concrete over the sill of the Tunnel to specified levels (in consultation and coordination with Contractor-A) and within permitted tolerances and provide keying /shear connectors for the 2nd pour concrete	
TK/UG-03: Shall set the track to the 'monument plates' provided by the civil contractor (Contractor-B) which will be verified prior to laying / concreting the Track.		TK/UG-03: Shall provide to the Track contractor 'monument plates' for setting the permanent track to its correct position.	
TK/UG-04: Shall provide the track Drainage system in the 2nd pour concrete consistent with the General Drainage arrangements constructed by the Tunnel Contractor (Contractor-B).		TK/UG-04: Shall furnish levels/details of the Drainage system in the Tunnel to Track contractor (Contractor-A) duly ensuring that Track Drainage is compatible with the General Drainage system (overall drainage scheme).	
TK/UG-05: To decide openings/way, storage spaces and schedule Access Periods jointly with Tunnel contractor (Contractor-B) and ensure implementation based on Track construction program.		TK/UG-05: Shall provide the required openings/way to take the track materials/plant/equipment underground for track laying and provide storage space for Track materials in consultation with track contractor and to permit access to track contractor for construction of Track as per agreed schedule of Access Periods.	
TK/UG-06: To furnish details of requirement of services to Tunnel Contractor (Contractor-B).		TK/UG-06: Shall provide services (water, power, and light) for construction of track. To Design and construct water supply schemes for Tunnel Work in consultation with Track Contractor.	

Contract A: Track (Interface Lead)		Contract B : UG Tunnels UGC-02 (Interface follower)		Sheet # : 2/2
Contract A (TRACK)	TEST & COMMISSIONING STAGE	Contract B (UG-TUNNEL)		
TK/UG-07: Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the S.O.D		TK/UG-07: Shall attend and assist in the joint check with concerned interface contractors to ensure that all permanent structures are clear of the structure gauge specified in the approved S.O.D		
Contract A (TRACK)	MAINTENANCE STAGE	Contract B (UG-TUNNEL)		
NIL		NIL		

7. Power Supply System (Power Supply and Traction; PST) and UG Stations and Tunnel (UGC-02)

Contract A: Power Supply System (PST) (Interface Lead)		Contract B : UG Tunnels UGC-02 (Interface follower)	Sheet # : 1/5
Contract A(Power supply system)	DESIGN STAGE	Contract B(UG Station & Tunnel)	
<u>Tunnel:</u> PS/UG-01: Contractor-A shall specify the cable routing and section needed at the interface between Tunnel and station. PS/UG-02: Contractor-A shall specify Size and space in the Tunnel for the <u>PST</u> and <u>PS SCADA</u> cable containments/ <u>brackets</u> /trunking/trench PS/UG-03: Contractor-A shall give the cable installation/Laying program Including starting and finishing chainage. PS/UG-04: Shall study and agree Structural gauge clearance. <u>UG Stations:</u> PS/UG-05: Contractor-A shall request the structural openings for cable entries/exit in regard of the chainage and agree jointly. PS/UG-06: Contractor-A shall request cable containments/trunking /brackets for <u>PST</u> cable routing. PS/UG-07: Shall provide inputs to combined services drawings (CSD) for detailed cable (for duct bank/cable trays/Cable troughs/Cable shafts and etc.....) layout/routing/Laying [HV and LV cables crossing to be avoided] within the Station and cable crossing at stations. PS/UG-08: Contractor-A shall request the total power load in the underground Station (including tunnels and subways etc.) from Contractor 'B' and accordingly design the transformer capacity.		<u>Tunnel:</u> PS/UG-01: Shall design the section accordingly in the Tunnel. PS/UG-02: Contractor-B shall study the alignment with chainage and space availability in the Tunnel and design <u>PST</u> and <u>PS SCADA</u> cable containments/ <u>brackets</u> /trunking/trench in tunnel. PS/UG-03: Shall plan accordingly to meet the requirement. PS/UG-04: Shall provide the Structural gauge clearance. <u>UG Stations:</u> PS/UG-05: Shall design the structural openings and provide the combined service drawings and agree jointly. PS/UG-06: Contractor-B shall install cable <u>Containment/brackets</u> /trays/trunking required for all cable routings PS/UG-07: Shall prepare the combined services drawings (CSD) in time required for the cable layout/routing/Laying within the Station and cable crossing at stations. PS/UG-08: Contractor-B shall give the details of total power load of the Station (including tunnels and subways etc.) by collecting the load requirements from all other sub-contractors (interfacing and project Contractors) to the TVS/ECS Contractor and TVS.ECS Contractor shall submit to Contractor 'A'	

Contract A: Power Supply System (PST) (Interface Lead)		Contract B : UG Tunnels UGC-02 (Interface follower)	Sheet # : 2/5
<p>PS/UG-09: Contractor-A shall design the technical room layout including builders works requirement in accordance with the finalized space provision. Contractor-A shall furnish room layout with equipment foot prints and equipment static and dynamic load and shall co-operate and co-ordinate with contractor-B.</p> <p>PS/UG-10: Contractor-A shall specify the operating temperature (ventilation), illumination parameters affiliated to electrical technical rooms</p> <p>PS/UG-11: Contractor-A shall request for signage boards for all HV equipment and technical rooms</p> <p>PS/UG-12: Contractor-A shall co-ordinate with 'Contractor B' to design best access for lifting facilities for electrical machineries/plants/equipment for installation and easy maintenance wherever required.</p> <p>PS/UG-13: Shall Design the earthing for HV and LV power supply systems including building structures and request for appropriate earth bus routing in the technical/plant rooms.</p> <p>PS/UG-14: Contractor-A shall be in the up-stream and request the type of tripping and protections required for the station equipment and design the equipment accordingly to meet the requirements.</p>		<p>PS/UG-09: Shall incorporate 'Contractor A' requirements in UG station design and shall co-operate and co-ordinate with contractor-A.</p> <p>PS/UG-10: Contractor-B shall design illumination (lux level) according to electrical technical rooms specification requirements</p> <p>PS/UG-11: Contractor-B shall design the signage as per requirement of contractor-A</p> <p>PS/UG-12: Contractor-B shall consider in the station design the requirements pertaining to access for lifting facilities and easy maintenance for Electrical equipment in close Co-ordination with 'Contractor A'.</p> <p>PS/UG-13: Contractor-B Shall co-ordinate with the 'Contractor A' and design the station earthing pits and earthing bus in the technical/plant rooms.</p> <p>PS/UG-14: Contractor-B shall co-ordinate with all other contractors (Interfacing/Project Contractors) and collect the data of type of tripping and protection they have in their equipment and handing over to TVS/ECS Contractor and by TVS/ECS Contractor to</p>	
Contract A(Power supply system)	CONSTRUCTION / INSTALLATION STAGE	Contract B(UG Station & Tunnel)	
<p><u>Tunnel:</u></p> <p>PS/UG-15: Shall check the PST cable <u>routing/ cable containment/brackets/</u> trunking provided by contractor-B.</p>		<p>PS/UG-15: Shall provide the quality tunnel lining and co-ordinate with Contractor-A.</p>	

Contract A: Power Supply System (PST) (Interface Lead)	Contract B : UG Tunnels UGC-02 (Interface follower)	Sheet # : 3/5
<p>PS/UG-16: Shall check the cable laying works requirements like routing, Sections, cross passages and confirm.</p> <p>PS/UG-17: Shall check the total space in the tunnel for cable laying works and confirm.</p> <p>PS/UG-18: Shall check the structural openings for cable entries/exit in regard of the chainage.</p> <p>PS/UG-19: Shall provide the cable laying works program and schedule.</p> <p>PS/UG-20: Space should be free of obstacles at the time of cable laying Works.</p> <p><u>UG Stations:</u> PS/UG-21: Contractor-A Shall install the rated capacity Transformer</p> <p>PS/UG-22: Shall jointly check the technical rooms made ready by 'Contractor B' and the same shall be confirmed.</p> <p>PS/UG-23: Shall jointly check the arrangements made ready for cable routing/Laying [HV and LV cables crossing to be avoided] within the Station and cable crossing at stations and to be confirmed.</p> <p>PS/UG-24: Shall jointly check the arrangements made ready for ventilation, Air conditioning and illumination within the Station rooms and to be confirmed.</p> <p>PS/UG-25: Shall jointly check the signage provided for all the technical rooms and to be confirmed.</p>	<p>PS/UG-16: Shall co-ordinate with contractor-A.</p> <p>PS/UG-17: Shall co-ordinate with contractor-A.</p> <p>PS/UG-18: Shall co-ordinate with contractor-A.</p> <p>PS/UG-19: Shall co-operate and agree with contractor-A.</p> <p>PS/UG-20: Site will be cleared free from obstacles and handed over for cable laying works.</p> <p>PS/UG-21: Shall construct the suitable solid foundation/Platform sufficiently at "out of reach of flood", and co-ordinate accordingly for civil and structural works.</p> <p>PS/UG-22: Technical rooms shall be made ready with lighting, small power, fire Detection and Fire Fighting systems, Cable Trays/ Supports/trenches/ Troughs Etc. and Shall be co-operated/co-ordinated with 'Contractor A'.</p> <p>PS/UG-23: All the necessary arrangements shall be made ready for the cable routing/Laying and shall be co-operated/coordinated with 'Contractor A'.</p> <p>PS/UG-24: Rooms should be ready with the requirements of ventilation, Air conditioning and illumination (lux level) and shall be co-operated/coordinated with 'Contractor A'.</p> <p>PS/UG-25: Signage for all technical rooms should be made ready and shall be Co-operated/co-ordinated with 'Contractor A'.</p>	

Contract A: Power Supply System (PST) (Interface Lead)		Contract B : UG Tunnels UGC-02 (Interface follower)	Sheet # : 4/5
<p>PS/UG-26: Shall jointly check the access provided for lifting facilities for electrical machineries for installation and easy maintenance and to be confirmed.</p> <p>PS/UG-27: Shall jointly check the earthing works and earth bus in the Technical rooms required for High Voltage and Low Voltage power supply systems including the building structures and to be confirmed.</p> <p>PS/UG-28: Shall jointly check the arrangements for cable crossing at station and to be confirmed.</p> <p>PS/UG-29: Contractor-A shall incorporate in his systems the requirements of tripping and protection and the same shall be confirmed.</p> <p>PS/UG-30: Shall Request the Temporary power requirement.</p> <p>PS/UG-31: Shall request the temporary storage area in the station building</p>		<p>PS/UG-26: Access for lifting facilities and easy maintenance for Electrical equipment shall be made ready as per the requirements and shall be co-operated/co-ordinated with 'Contractor A'.</p> <p>PS/UG-27: All the earthing works shall be made ready and handed over to Contractor-A.</p> <p>PS/UG-28: Requirements for cable crossing shall be made ready and shall be Co-operated/co-ordinated with 'Contractor-A'.</p> <p>PS/UG-29: Contractor-B shall hand over all the protection and tripping systems of all other Contractors (Project contractors) in the station to 'Contractor- A' through TVS/ECS Contractor and shall Co-operate/co-ordinate.</p> <p>PS/UG-30: Shall provide the temporary power requirement at one place</p> <p>PS/UG-31: Shall study the space availability in the station and provide</p>	
Contract A(Power supply system)	TEST & COMMISSIONING STAGE	Contract B(UG Station & Tunnel)	
<p><u>Tunnel:</u> PS/UG-32: Space should be free from man and material.</p> <p><u>UG Stations:</u></p> <p>PS/UG-33: Shall jointly check the parameters of ventilation and Air conditioning within the Station rooms and to be confirmed.</p> <p>PS/UG-34: Shall jointly check the resistance of all earthing works at station required for High Voltage and Low Voltage power supply systems including the building structures and to be confirmed.</p> <p>PS/UG-35: Shall request Space free from human interference and materials.</p> <p>PS/UG-36: Prepare joint maintenance procedures in consultation with contractor-B and Shall jointly agree and accept.</p>		<p>PS/UG-32: As per the requirement shall agree and do the needful.</p> <p>PS/UG-33: Shall jointly co-ordinate to check the parameters of ventilation and Air conditioning with 'Contractor A'.</p> <p>PS/UG-34: Shall jointly check the resistance of all earthing works made at station and shall be co-operated/co-ordinated with 'Contractor A'.</p> <p>PS/UG-35: Shall arrange Space free from human interference and materials.</p> <p>PS/UG-36: Validate and accept joint Maintenance procedure with contractor-A</p>	

8. OHE (PST) and UG Tunnel (UGC-02)

Contract A: OHE (Interface Lead)		Contract B : UG Tunnels UGC-02 (Interface follower)	Sheet # : 1/3
Contract A(OHE)	DESIGN STAGE	Contract B(UG Tunnel)	
<u>Rigid catenary system for tunnel</u> OH/UG-01: Shall design all the required fixings to support rigid overhead contact system according to Contractor-B constraints. OH/UG-02: Shall transmit his fixing design details to the Contractor-B and the Engineer for notice of no objection. OH/UG-03: Shall furnish the details of height of contact wire and the minimum electrical clearances needed. OH/UG-04: Shall design the OHE according to the gradients and curves. OH/UG-05: Neutral section to be located on straight track and having negligible gradient. <u>Shall provide the requirements/details and location of the Neutral Section to Contractor B.</u> OH/UG-06: Shall design and fix all required fixings of the beam to support rigid overhead contact system for tunnel launching area (TBM launching area) according to Contractor-B constraints. Shall transmit his fixing design details to the Contractor-B and the Engineer for notice of no objection. <u>Drop arm and its base fixing arrangement in tunnel.</u> OH/UG-07: Shall design the type of drop arm and shall fix in accordance with the agreed fixing details. OH/UG-08: Shall design and furnish the span of drop arms of OHE.		OH/UG-01: Shall provide segment & tunnel lining details and limit of fixing penetrations. OH/UG-02 Shall provide notice of no objection once the fixing details are agreed. OH/UG-03: Shall design the structures accordingly. OH/UG-04: Shall furnish the gradients and curve details. OH/UG-05: Shall provide the gradient chart and curve details. <u>Shall adjust/modify the vertical alignment of the tunnels at the Neutral Section location as may be required to suit the requirements of Contractor B for installation of Neutral Section.</u> OH/UG-06: Shall provide segment, RCC structure & tunnel lining details and limit of fixing penetrations. Shall provide notice of no objection once fixing details are agreed. OH/UG-07: Shall provide notice of no objection to Contractor-A, once fixing details are agreed. OH/UG-08: Shall furnish the details of curves/alignment.	

Contract A: OHE (Interface Lead)		Contract B : UG Tunnels UGC-02 (Interface follower)	Sheet # : 2/3
<p>OH/UG-09: Obligatory drop arm to be furnished (if any).</p> <p>OH/UG-10: Loading on drop arm to be provided.</p> <p>OH/UG-11: KM no / Drop arm no of drop arm location to be prepared.</p> <p><u>Earthing of OHE in underground tunnel.</u></p> <p>OH/UG-12: Shall design and provide necessary details of earthing (Buried Earth conductor and Overhead protection cable).</p> <p>OH/UG-13: Shall provide the drawing of conduit carrying the buried earth conductor.</p> <p>OH/UG-14: Shall provide the details of structure bonds including locations.</p>		<p>OH/UG-09: Shall provide the details of the location of points and crossings,</p> <p>OH/UG-10: Collect the details of drop arm loading.</p> <p>OH/UG-11: Shall furnish the KM details of tunnel.</p> <p>OH/UG-12: Shall coordinate and fulfil the requirements of provision in civil works for earthing as per the design provided by Contractor-A.</p> <p>OH/UG-13: Shall coordinate and fulfil the requirements for carrying the buried earth conductor.</p> <p>OH/UG-14: Shall coordinate and fulfil the requirements.</p>	
Contract A(OHE)	CONSTRUCTION / INSTALLATION STAGE	Contract B(UG Tunnel)	
<p>OH/UG-15: Shall cross check the programme/planning of implementation.</p> <p>OH/UG-16: Shall cross check and keep records (jointly signed) of all Requirements as the Work progresses.</p> <p>OH/UG-17: Shall tackle the notified changes if any.</p>		<p>OH/UG-15: Shall coordinate</p> <p>OH/UG-16: Shall report progress of construction at mutually agreed intervals.</p> <p>OH/UG-17: Shall furnish the changes in design/plan if any.</p>	
Contract A(OHE)	TEST & COMMISSIONING STAGE	Contract B(UG Tunnel)	
<p>OH/UG-19: Shall Test the brackets.</p>		<p>OH/UG-19: Shall agree and accept the bracket testing.</p>	

Contract A: OHE (Interface Lead)		Contract B : UG Tunnels UGC-02 (Interface follower)	Sheet # : 3/3
<p>OH/UG-20: Shall provide testing procedure.</p> <p>OH/UG-21: Shall measure the earth resistance values of all locations and display and keep the records.</p>		<p>OH/UG-20: Shall agree and accept.</p> <p>OH/UG-21: Shall co-operate.</p>	
Contract A(OHE)	MAINTENANCE STAGE	Contract B(UG Tunnel)	
<p>OH/UG-22: Shall agree and accept.</p> <p>OH/UG-23: Shall measure and record earth resistance values jointly at suitable interval</p>		<p>OH/UG-22: Shall stop water leakage and maintain water tight tunnels to the Contract Specifications.</p> <p>OH/UG-23: Shall co-operate.</p>	

9. OHE (PST)and UG Stations (UGC-02)

Contract A: OHE (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 1/2
Contract A(OHE)	DESIGN STAGE	Contract B(UG-Station)	
<u>Rigid catenary system and its insulators.</u>			
OH/UG-01: Shall design Rigid catenary system and furnish details including locations, Loads etc.,		OH/UG-01: Shall design and construct the base support fixtures on soffit of Concourse level (or as required) to support the rigid catenary system.	
OH/UG-02: Shall furnish the details of height of contact wire and the minimum electrical clearances needed.		OH/UG-02: Shall design the soffit of Concourse structures accordingly.	
OH/UG-03: Shall furnish the space requirement of traction cabin for provision of equipment of sub-sectioning and paralleling post, sectioning post, sub- sectioning post if needed.		OH/UG-03: Shall provide size of cabin as required by Contractor-A.	
OH/UG-04: Shall provide drawings showing the locations, Cable ducts and sizes of Openings for passage of cables including routing.		OH/UG-04: Shall provide combined builders drawings/CSDs and agree jointly and provide cable route openings as per drawing.	
OH/UG-05: Shall design obligatory catenary/OCS location.		OH/UG-05: Provide the details of crossovers, turnout etc. if any.	
<u>Earthing of OHE in underground station.</u>			
OH/UG-06: Shall design and provide necessary details of earthing (Buried Earth Conductor and Overhead Protection Cable).Shall furnish the drawings.		OH/UG-06: Shall coordinate and implement the earthing system of building structures, platform, over/under pass/shelters etc. to be ultimately connected to buried earth conductor and Arial earth cable.	
OH/UG-07: Shall provide the details of connecting link terminal locations.		OH/UG-07: Shall coordinate and implement the locations of connecting links.	
Contract A(OHE)	CONSTRUCTION / INSTALLATION STAGE	Contract B(UG-Station)	
OH/UG-08: Shall check the load of supporting fixtures of catenary/OCS system.		OH/UG-08: To assist and cross check the load requirements.	
OH/UG-09: Shall review the progress at suitable interval.		OH/UG-09: Shall report progress of construction at mutually agreed intervals.	

Contract A: OHE (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 2/2
OH/UG-10: Shall seek access to work.		OH/UG-10: Shall provide the access to work area in underground stations	
Contract A(OHE)	TEST & COMMISSIONING STAGE	Contract B(UG-Station)	
OH/UG-11: Cross check the loading by OHE and agree.		OH/UG-11: Test the base supporting fixture load carrying capacity jointly.	
OH/UG-12: Measure the earth resistance values of all locations and display and keep the records (i.e., Combined Earth resistance value: 0.5 ohms, Individual Earth resistance value: 10 ohms)		OH/UG-12: Shall coordinate and put joint efforts to bring earth values to below maximum prescribed/required values.	
Contract A(OHE)	MAINTENANCE STAGE	Contract B(UG-Station)	
OH/UG-13: Measure and record earth resistance values jointly at suitable interval.		OH/UG-13: Shall co-operate.	

10. Signalling & Telecommunication and UG Stations (UGC-02)

Contract A: Signalling & Telecommunication (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 1/6
Contract A(Signalling & Telecom)	DESIGN STAGE	Contract B(UG-Station)	
<p>ST/US-01: Shall furnish the space and mechanical load requirements of the Signal Equipment Room (SER), Communication Equipment Room (CER), Station Control Room (SCR), Telecom closets and lighting, flooring, false flooring, cable duct and vertical cable risers in the above mentioned rooms.</p> <p>ST/US-02: Shall furnish the sizes of S & T equipment to be installed in SER, CER, SCR and Telecom Closets.</p> <p>ST/US-03: Shall furnish the detailed drawings of line side equipment to be installed like signals, point machines, signal post telephones, ATP ATO equipment, Train stoppage beacons, antennas, impedance bonds (where applicable) and location boxes etc.,</p> <p>ST/US-3A:a) Shall furnish the routing of the cables for S&T equipment in whole Station b) Shall validate the synthesis cable routing layout proposed by Contractor-B</p> <p>ST/US-04: a) Shall furnish the detailed drawings of main cable routing arrangements in respect of S & T cables in the station (including requirements of minimum 1 meter separation between S & T cables and HV cables). Shall furnish the details of Signal & Telecommunication cables like dimensions, weight, minimum bending radius and supporting & mounting details. b) Shall provide detailed drawings with the locations of all equipment and cables to be installed on the track.</p>		<p>ST/US-01: a) Shall provide station layout and drawings showing the rooms and vertical cable risers etc. b) Shall Update the Station drawings to accommodate the requirements of Contractor- A. c) Shall collect the data & integrate with other users and provide it to all the Interfacing/Project Contractors.</p> <p>ST/US-02: All corridors and doors shall be sized to enable equipment to be delivered to SER, CER, SCR and Telecom Closets for installation and replacements.</p> <p>ST/US-03: Shall suitably incorporate the detailed drawings/requirements prepared by Contractor-A.</p> <p>ST/US-3A: Shall establish the synthesis layout for cable routing according to all the Sub-systems layouts</p> <p>ST/US-04: a) & b) Shall design the cable routing and cable containments in the station.</p>	

Contract A: Signalling & Telecommunication (Interface Lead)	Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 2/6
<p>c) Shall provide detailed drawings of locations, loads, type of fixing/mounting arrangements for signalling and Telecommunication equipment to be installed on the platform, Mezzanine(where applicable), concourse and entrance levels like PA system, PID's, CCTV cameras, clocks, CCTV monitors, emergency stop plungers and staff protection keys etc.</p> <p>ST/US-05: Shall furnish the locations and space requirements of passenger emergency communication and help point equipment to be installed.</p> <p>ST/US-06: Shall furnish the locations and details of access control system and Intrusion detection system.</p> <p>ST/US-07: Shall furnish the requirements of earthing arrangement including earth impedance value for different S & T systems to be installed in SER, CER, Telecom closets and SCR and line side equipment</p> <p>ST/US-08: a) Shall design the M & E SCADA system to suit the requirements of controlled / monitored Non-traction SCADA systems to be installed by Contractor-B.</p> <p>b) Shall validate the interface design. Design the connectivity requirements from the interface devices up to the CER and to the SCR / OCC.</p> <p>c) Shall design the HMI of M&E SCADA at the SCR and OCC to meet the control and monitoring requirements of equipment installed by Contractor-B.</p> <p>ST/US-09: Shall furnish the requirements of signs and labels except for equipment installed by Contractor- B.</p> <p>ST/US-10: Shall furnish the EMI / EMC levels of S & T equipment to be installed in stations.</p>	<p>c) For heavy equipment like CCTV monitors, display boards, analogue clocks etc., to be mounted on walls / suspended from the roof, Contractor-B shall integrate the fixing arrangements with the structural design.</p> <p>ST/US-05: Shall validate the locations of passenger emergency communication system and help point system.</p> <p>ST/US-06: Shall validate the locations of access control system and intrusion detection system.</p> <p>ST/US-07: Shall provide the earthing arrangement for different systems and extend it up to SER, CER and SCR and Telecom Closets accordingly; Shall also extend the earth for earthing of line side equipment, if required.</p> <p>ST/US-08: a) Contractor-B shall define the control / monitoring requirements and parameter measurement requirements (zone/ group). Contractor- B shall install the local control panel (LCP) and wire it to control all controlled devices. Contractor-B shall provide the interface devices with M & E SCADA.</p> <p>b) Shall design the interface device for each monitored / controlled equipment, Local control panel (where applicable) for the station M & E equipment, LV power distribution , UPS, DG , lighting systems and building management systems installed under the Contract B.</p> <p>c) Shall advise the locations and connectivity requirements of interface devices associated with M & E equipment to be monitored / controlled by non- traction SCADA.</p> <p>ST/US-09: Shall design all the statutory signs and labels except for S & T equipment.</p> <p>ST/US-10: Shall incorporate in station design and prepare a common EMI / EMC plan.</p>	

Contract A: Signalling & Telecommunication (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 3/6
<p>ST/US-11: Shall furnish the acoustic intelligibility and lighting visibility criteria to ensure that the performance of PA and PID systems are as per laid down standards.</p> <p>ST/US-12: Shall furnish the requirements of temporary power supply for preliminary testing of S & T equipment installed in stations.</p> <p>ST/US-13: Shall validate the interface document and relevant portion of technical specifications of fire protection system.</p> <p>ST/US-14: a) Shall furnish the detailed load requirement of various S & T equipment for the UPS (240V) power supply. b) Shall design the power cable requirement from distribution panel in UPS room to SER / CER / Telecom closets.</p> <p>ST/US-15: Prepare joint maintenance plan involving M & E SCADA of S & T and station M & E equipment / power supply systems / UPS /DG/ Lighting system / building management functions.</p>		<p>ST/US-11: Shall accommodate the requirements of Contractor- A and furnish the architectural design details of the stations.</p> <p>ST/US-12: Shall plan the power supply system accordingly.</p> <p>ST/US-13: Shall design the interfacing of fire system with PA system etc. and provide the relevant technical specifications of fire protection system.</p> <p>ST/US-14: Shall design the UPS with Suitable protection devices at the output accordingly.</p> <p>ST/US-15: Validate the joint maintenance plan.</p>	
Contract A(Signalling & Telecom)	CONSTRUCTION / INSTALLATION STAGE	Contract B(UG-Station)	
<p>ST/US-16: Shall verify that the requirements of lighting, false flooring (for prescribed load levels) and vertical cable risers in SER, CER, Telecom Closets and SCR are as per the requirement.</p> <p>ST/US-17: Shall install all signalling and communication cables and provide the connections to individual devices.</p> <p>ST/US-18: Shall install the line side S & T equipment like signals, ATP/ATO equipment, antennas, train stoppage beacons, location boxes, signal post telephones and impedance bonds etc.</p>		<p>ST/US-16: Shall provide the lighting, false flooring (for prescribed load levels) and vertical cable risers in SER, CER, Telecom Closets and SCR.</p> <p>ST/US-17: Shall ensure provision of cable ducts, main cable crossing arrangements, including openings required for entry / exit arrangements for main S & T cables in the station.</p> <p>ST/US-18: Shall provide the necessary arrangements to install line side S & T equipment like signals, ATP / ATO equipment, antennas, train stoppage beacons, location boxes, signal post telephones and Impedance</p>	

Contract A: Signalling & Telecommunication (Interface Lead)	Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 4/6
<p>ST/US-19: Shall install the emergency communication and help point equipment.</p> <p>ST/US-20: a) Shall arrange the mounting and fixing accessories to station Contractor (Contractor-B). b) Shall install the equipment at stations like staff protection keys, Emergency stop plungers, PIDs, PA system, clocks, CCTV cameras and Television system equipment etc.,</p> <p>ST/US-21: Shall install the access control system and intrusion detection system.</p> <p>ST/US-22: Shall verify that the requirements of earthing system are met.</p> <p>ST/US-23: Shall install the M & E SCADA system at the OCC & SCR and provide LAN connectivity up to interface device for all controlled / monitored systems installed by Contractor- B.</p> <p>ST/US-24: Shall verify the requirements of statutory signs and labels.</p> <p>ST/US-25: Shall bring the power supply from distribution panel to SER /CER.</p> <p>ST/US-26: Shall verify the interfacing of fire system with PA system.</p> <p>ST/US-27: Shall install the power cables from the distribution panel in UPS room to SER / CER and extend it to the SCR, Telecom Closets etc.,</p>	<p>ST/US-19: Shall provide necessary arrangements to install emergency communication and help point equipment.</p> <p>ST/US-20: Shall install the mounting and fixing arrangements for heavy equipment like CCTV monitors, display boards, analogue clocks etc., during the construction as per the S & T requirements.</p> <p>ST/US-21: Shall provide necessary arrangements to install access control and intrusion detection systems.</p> <p>ST/US-22: Shall install earths and earth bars for S & T equipment for various systems and terminate inside the main equipment rooms, SCR and telecom closets and on the tunnel side (if required) for earthing of line side signalling and Telecommunication systems (if required).</p> <p>ST/US-23: Shall provide, wire and connect the interface devices upto the station LAN port provided by Contractor-A for various equipment, local control panels (where applicable) for M & E equipment, LV power distribution system, UPS system, DG, lighting system and building management system etc., forming part of Contract- B.</p> <p>ST/US-24: Shall install all the statutory signs and labels except those relating to S & T equipment.</p> <p>ST/US-25: Shall provide the temporary power supply with suitable protection arrangements.</p> <p>ST/US-26: Shall install the fire alarm and control system and provide the necessary interfaces with PA system.</p> <p>ST/US-27: Shall install the UPS and suitable protection devices at the output.</p>	

Contract A: Signalling & Telecommunication (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 5/6
ST/US-27A: Shall run the LAN cable from station to all cross passage and permanent access egress location		ST/US-27A: Shall provide the cable tray/ladders for LAN cable routing	
Contract A(Signalling & Telecom)	TEST & COMMISSIONING STAGE	Contract B(UG-Station)	
ST/US-28: Shall conduct a joint test with Civil (Underground stations) Contractor for testing of earth impedance of all earths provided for tunnels & stations. ST/US-29: Shall conduct joint testing on the networking, monitoring & control (where applicable) of M & E, LV distribution, UPS, DG, lighting system and building management systems etc., (provided under the Station Contract— Contract-B) through the M & E SCADA from OCC and SCR as per jointly agreed control logic and display formats. ST/US-30: Shall conduct the joint testing and confirm that there are no EMI / EMC impacts on S & T equipment installed in stations. ST/US-31: Shall conduct joint testing on the functioning of fire and PA system inter connection. ST/US-32: Shall conduct joint load test with suitable loads for temporary power supply. ST/US-33: Shall conduct joint load test with suitable loads for UPS supply.		ST/US-28: Shall attend the joint testing of earth impedance with Contractor-A ST/US-29: Shall attend the joint testing and validate the test results. ST/US-30: Shall attend the joint testing with S & T, RS and OHE contractors. ST/US-31: Shall attend the joint testing and validate the results. ST/US-32: Shall attend the joint tests with Contractor- A. ST/US-33: Shall attend the joint testing and validate the results.	
Contract A(Signalling & Telecom)	MAINTENANCE STAGE	Contract B(UG-Station)	
ST/US-34: Finalise the joint maintenance procedures and periodicity of joint inspection <ul style="list-style-type: none"> a. Between S & T and station maintenance for testing of various S&T earths b. Between M & E SCADA and station M & E equipment / power supply system / lighting system etc., which are parts of building management functions. c. Joint maintenance procedures and include the same in the S & T maintenance manual. 		ST/US-34: Validate the joint maintenance procedures and test plans prepared by Contractor-A	

11. Signalling & Telecommunication and UG Tunnel (UGC-02)

Contract A: Signalling & Telecommunication (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)		Sheet # : 1/2
Contract A(Signalling & Telecom)	DESIGN STAGE	Contract B(UG-Tunnel)		
<p>ST/UT-01: Shall furnish the detailed drawings with locations and dimensions of line side equipment to be installed like signals, ATP / ATO equipment, antennas, impedance bonds, location boxes, cable termination, RF amplifiers, intrusion detection systems, Signs and labels and signal post telephones etc.</p> <p>ST/UT-02: Shall furnish the details of Signal & Communication cables like dimensions, weight, minimum bending radius and supporting & mounting details throughout Tunnel and stations including the track crossings</p> <p>ST/UT-03: Shall furnish the detailed drawings with all locations and dimensions of emergency communication equipment including passenger Emergency communication arrangements at cross passages. Shall plan to monitor the status of cross passage doors</p>		<p>ST/UT-01: Shall validate the location of intrusion detection devices, suitably incorporate the detailed drawings prepared by Contractor-A and integrate the fixing and mounting arrangements with the structural design.</p> <p>ST/UT-02: Shall design the mounting arrangements in the tunnel section to accommodate the cable containments / cable hangers and design the cable containments / cable hangers including the track crossing cable containments.</p> <p>ST/UT-03: Shall validate the locations of passenger emergency communication systems and design the fixing arrangements. Shall design and install the cross passage doors</p>		
Contract A(Signalling & Telecommunication)	CONSTRUCTION / INSTALLATION STAGE			
<p>ST/UT-04: Shall install the line side S & T equipment like signals, ATP/ATO equipment, antennas, location boxes, cable termination boxes, RF amplifiers, intrusion detection systems, signal post telephones, impedance bonds and emergency communication equipment.</p> <p>ST/UT-05: Shall install Signalling & Communication cables in tunnel sections.</p> <p>ST/UT-06: Shall verify the requirements of statutory signs and labels.</p>		<p>ST/UT-04: Shall provide the necessary mounting /fixing arrangements to install line side S & T equipment like signals, ATP / ATO equipment, antennas, location boxes, cable termination boxes, RF amplifiers, intrusion detection systems, signal post telephones, Impedance bonds and emergency communication equipment.</p> <p>ST/UT-05: Shall provide cable containments / cable hanger fixings and track crossings as per the requirements.</p> <p>ST/UT-06: Shall install all the statutory signs and labels except those relating to S & T equipment.</p>		
Contract A(Signalling & Telecom)	TEST & COMMISSIONING STAGE		Contract	
<p>ST/UT-07: Shall conduct joint inspection of cable containments/ cable hangers, track crossing cable ducts installation.</p> <p>ST/UT-08: Shall agree and accept.</p>		<p>ST/UT-07: Shall attend the joint inspection of cable ducts / cable hangers installation.</p> <p>ST/UT-08: Shall stop water leakages & maintain water tight tunnels to the Contract Specifications.</p>		

12. PSD (S&T) and UG Stations (UGC-02)

Contract A: PSD (S&T) (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 1/2
Contract A(PSD-S&T)	DESIGN STAGE	Contract B(UG-Station)	
<p>ST/US-01: (a) Shall furnish the specification of Platform Screen Doors (PSD) like dimensions, weight and supporting & mounting details throughout stations.</p> <p>(b) Shall furnish the maximum load of PSD on platform edge</p> <p>ST/US-02: Shall furnish the requirements of passenger emergency escape doors and track access doors.</p> <p>ST/US-03: Shall furnish the installation location and method of Platform Screen Doors Local Control Panel on platform level.</p> <p>ST/US-04: Shall furnish the requirement of earthing system including earth impedance value and earth bars for the PSD equipment.</p> <p>ST/US-05: Shall furnish the EMI / EMC levels of PSD equipment to be installed in stations.</p> <p>ST/US-06: Shall furnish the details of DG and UPS power supply requirement for PSD Operation</p> <p>ST/US-07: Shall furnish the interfacing details with fire detection and firefighting systems</p> <p>ST/US-08: Shall furnish the cable routing plan to Contractor-B</p>		<p>ST/US-01: (a) Shall validate and find the locations of Platform Screen Doors (PSD) and design space, hanger walls / beams & necessary supports, structural and platform slab by considering the Dimensions, weight and mounting details of PSD.</p> <p>(b) Shall collect details from Contractor-A and design the platform to accommodate PSD load requirement.</p> <p>ST/US-02: Shall validate and find the locations of passenger emergency escape doors and track access doors.</p> <p>ST/US-03: Shall validate and find the locations of Platform screen doors local control panel.</p> <p>ST/US-04: Shall fulfil the requirements of earthing and earth bars.</p> <p>ST/US-05: Shall incorporate in station design and prepare a common EMI / EMC plan.</p> <p>ST/US-06: Shall design the DG and UPS power supply requirement for PSD Operation</p> <p>ST/US-07: Shall plan and take signal from PSD and integrate with fire detection and firefighting systems</p> <p>ST/US-08: Shall design cable duct/containment for PSD cable routing</p>	
Contract A(PSD-S&T)	CONSTRUCTION / INSTALLATION STAGE	Contract B(UG-Station)	
<p>ST/US-09: Shall install the Platform Screen Doors, Emergency Escape Doors, Track access doors and Platform screen doors local control panels.</p>		<p>ST/US-09: Shall provide necessary supports to install the platform screen doors and local control panels.</p>	

Contract A: PSD (S&T) (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 2/2
<p>ST/US-10: Shall verify the requirements of earths and earth bars.</p> <p>ST/US-11: Shall install control panel, power and control cable according to plan layout</p>		<p>ST/US-10: Shall install earths and earth bars for Platform screen doors and its equipment to be installed in Stations.</p> <p>ST/US-11: Shall install cable containment/ducts to install control panel, power and control cable according to plan layout</p>	
Contract A(PSD-S&T)	TEST & COMMISSIONING STAGE	Contract B(UG-Station)	
<p>ST/US-12: Shall conduct a joint test with Civil Contractor (Contractor-B) for testing of earth impedance of all earths provided for the PSD Equipment.</p> <p>ST/US-13: Shall conduct the joint testing and confirm that there are no EMI / EMC impacts on PSD equipment installed in stations.</p>		<p>ST/US-12: Shall attend the joint testing of earth impedance with Contractor-A.</p> <p>ST/US-13: Shall attend the joint testing with S&T (PSD) and OHE contractors.</p>	
Contract A(PSD-S&T)	MAINTENANCE STAGE	Contract B(UG-Station)	
<p>ST/US-14: Shall conduct the joint testing and confirm that there are no EMI / EMC impacts on PSD equipment installed in stations.</p>		<p>ST/US-14: Shall attend the joint testing with S & T (PSD) and OHE contractors.</p>	

13. AFC and UG Stations (UGC-02)

Contract A: AFC (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 1/4
Contract A(AFC)		DESIGN STAGE	Contract B(UG-Station)
1. Provision of Rooms and Areas for Equipment Lay-out AF/US-01: Shall finalise the room schedule and lay-out for AFC at stations		AF/US-01: Shall incorporate the space and room requirements in the station Design	
2. Mechanical and Structural Interfaces AF/US-02: Shall provide details of AFC equipment with specific requirements for installation. <ol style="list-style-type: none"> Granite Counters for TO Cable routing and Fixing arrangements for Cable Trays Gate array cable trench and raise way/raceway Passenger Windows at TO and EFO Wall Opening for TVM at SS 		AF/US-02: Shall incorporate the requirements in the station design for <ol style="list-style-type: none"> Granite counter for TO Provision for Cable routing Gate array cable trench and raise way/raceway Passenger Windows at TO and EFO Wall Opening for TVM at SS 	
3. Earthing AF/US-03: Shall provide design details of earthing requirements		AF/US-03: Shall Incorporate the earthing scheme for AFC system as per requirement	
4. Power supplies AF/US-04: Provide the DG and UPS Power estimate in the station for AFC equipment		AF/US-04: Shall design the DG and UPS power supply with suitable protection devices for AFC equipment in station	
5. Cable Routing, Penetration Installation & Cable containment AF/US-05: Shall provide the cabling scheme for AFC system and cable routing requirement for Power and Data.		AF/US-05: Shall space proof the cable routing requirement of AFC for Power and Data in the station design. Shall provide cable Containment	
6. Furniture AF/US-06: Shall provide the details of Granite Counter for TIW at Ticket Office		AF/US-06: Shall incorporate Granite Counter for TIW at Ticket office in the design.	
7. Labelling and Statutory Signs AF/US-07: Equipment related labelling and signage on AFC equipment and cables shall be designed by AFC contractor.		AF/US-07: All other signage at stations shall be designed by Station Contractor	

Contract A: AFC (Interface Lead)	Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 2/4
<p>8. EMC site Certification AF/US-08: Shall provide the EMC requirements of AFC</p> <p>9. Review of documents & Drawings AF/US-09: Shall review the drawings and documents for AFC requirements. e.g. : <ol style="list-style-type: none"> 1. Room Schedule 2. Station layout 3. Cable routing 4. Gate array etc. (Not limited to the above drawings and documents)</p> <p>10. Utilities Required for Site works AF/US-10: Shall specify the requirement of utilities for site Works <ol style="list-style-type: none"> 1. Temporary power 2. Lighting 3. Airconditioning at TO and SCR </p> <p>11. Storage at Site AF/US-11: Shall specify the temporary storage requirement for AFC equipment at the stations during installation</p> <p>12. Fire alarm interface AF/US-11A: (a) Shall design the AFC system to interface with fire alarm system. Shall also specify the details like type of signal, communication protocol etc. (b) Shall Design the software according to functional requirements in emergency condition</p>	<p>AF/US-08: To incorporate the AFC requirement in the design</p> <p>AF/US-09: Shall incorporate the review comments in the drawings and documents and finalise the station documentation.</p> <p>AF/US-10: Shall accommodate the requirements in his design.</p> <p>AF/US-11: Shall make provision for temporary space at concourse level to store AFC equipment on temporary basis during installation</p> <p>AF/US-11A: (a) Shall design the Fire Alarm system to interface with AFC system. Shall verify and accept mutually the details like type of signal, communication protocol etc., operation in emergency condition (b) Shall specify the functional requirements of AFC system</p>	

Contract A: AFC (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 3/4
Contract A(AFC)	CONSTRUCTION / INSTALLATION STAGE	Contract B(UG-Station)	
1. Provision of Rooms and Areas for Equipment Layout AF/US-12: 1. To confirm that the construction is as per the room schedule. 2. To request access from the station contractor (Contractor-B). 2. Mechanical and Structural Interfaces AF/US-13: 1.To check and confirm t h a t AFC specific requirements for installation are made available. 2.To install the electric cabinet and do the cable termination. 3.To install the switches and do the data cable termination. 4. To do the internal wiring at the AFC rooms. 5.To fix the AFC equipment at AFC rooms and complete the installation . 3. Earthing AF/US-14: To confirm that the earthing provided is as per the requirement and provide earthing for the equipment 4. Power supplies AF/US-15: Install/Lay the Power cable from UPS panel to AFC room 5. Cable Routing and Penetration Installation AF/US-16: To do the cable routing as per the cabling scheme for power & data. 6. Furniture AF/US-17: To check the details of Granite counter for TIW provided by the station contractor (Contractor-B). To provide the other furniture as is in the scope of AFC Contractor. 7. Labelling and Statutory Signs AF/US-18: To do the signage under the scope of AFC Contract., specific to AFC equipment and cabling.		AF/US-12: 1. To construct the room and gate area as per the AFC room Schedule 2. To provide access to AFC Contractor for the installation of equipment AF/US-13: To construct and provide civil and structural facilities required for AFC installation AF/US-14: To provide earthing as per AFC requirement AF/US-15: Provide permanent power from UPS with suitable protection devices as per AFC requirement AF/US-16: Provide cable containment as per AFC Contractor’s requirements AF/US-17: To provide Granite Counter for TIW at Ticket office as per approved design. AF/US-18: To provide the signage for operational requirements	

Contract A: AFC (Interface Lead)		Contract B : UG Stations UGC-02 (Interface follower)	Sheet # : 4/4
8. EMC site Certification AF/US-19: To check and confirm that the EMC requirements of AFC are met		AF/US-19: To meet the EMC requirement of the AFC in the station.	
9. Review of documents & Drawings AF/US-20: To review the as built drawings and documents as per the documentation plan.		AF/US-20: To provide the as built documents as per the documentation plan	
10. Utilities Required for Site works AF/US-21: To avail for installation of AFC equipment : <ol style="list-style-type: none"> 1. Temporary power 2. Lighting 3. Air-conditioning at TO and SCR 		AF/US-21: To provide the following utilities for installation of AFC equipment, <ol style="list-style-type: none"> 1. Temporary power 2. Lighting 3. Air-conditioning at TO and SCR 	
11. Storage at Site AF/US-22: To check the adequacy of the temporary storage space for AFC equipment at the concourse level and avail.		AF/US-22: To provide temporary storage space for the AFC equipment at concourse level.	
12. Fire alarm interface AF/ES-22A: Shall Install and connect the cable from AFC panel to Fire alarm control panel.		AF/ES-22A: Provide the interface terminal to AFC contractor.	
Contract A(AFC)	TEST & COMMISSIONING STAGE	Contract B(UG-Station)	
AF/US-23: Contractor-A shall jointly test the UPS systems		AF/US-23: Contractor-B shall jointly test the UPS systems with contractor-A	
Contract A(AFC)	MAINTENANCE STAGE	Contract B(UG-Station)	
NIL		NIL	

Attachment E Indicative Master Interface Matrix

	UGC-01 (Tunnel & Stations) : UGC-01	UGC-02 (Tunnel & Stations) : UGC-02	Elevated Contract	Tunnel Ventilation and UG Station Air-conditioning	Station Lifts and Escalators	Rolling Stock	Track Works	Power Supply System (PST)	OHE (PST)	Signalling and Telecommunication	PSD (S&T)	AFC
UGC-01 (Tunnel & Stations) : UGC-01												
UGC-02 (Tunnel & Stations) : UGC-02												

Attachment F Part 1 – Interface Coordination Sheet Form

Interface Coordination Sheet: UGC-01/UGC-02					Contractor -1 Logo	Contractor -2 Logo
INTERFACE PLAN					INTERFACE IMPLEMENTATION	
ICS No	Project Stage	Interface Plan Status	Interface Point Lead	Interface Plan Follower	Implementation Status	Action/Progress records & Follow-ups
A.1	Design	Completed	Contract-A shall design temporary and permanent drainage system in consultation with Contract-B	Contract-B shall plan drainage system with Contract-A	Note Ready	
A.2	Design	Completed	Contract-A shall design grounds treatment outside station wall for break-through	Contract-B shall Design station walls to accept break through by two TBMs (Tunnel boring machine)	Note Ready	

Attachment F Part 2 - Interface Coordination sheet Format

The following table provides an example of the Interfacing Party Contract codes, which can be used when preparing / updating the Contractor’s Interface Coordination Sheet, which should be prepared on the basis of a separate Excel spreadsheet for each Interfacing Party. These Interfacing Party Contract codes shall be finalised by the Engineer and made available to the Project Contractors.

Interface Party Codes	
CVT	Civil Tunnels
CSN	Civil Stations
CVD	Civil Depot
ARS	Architectural Stations
ARD	Architectural Depot
BSS	Building Service Stations
BSD	Building Service Depot
DEE	Depot Equipment
AFC	Automatic Fare Collection
SGC	Signalling and Communications
LEC	Lifts and Escalators
VAC	Ventilation & Air-Conditioning
TVS	Tunnel Ventilation System
PST	Traction Power (Includes OCS & SCADA)
RST	Rolling Stock
TWK	Track work

Attachment F Part 3 - Interface Coordination Sheet Format

The following table describes the Interface Status with codes to be used in preparing / updating the Interface Coordination sheet.

Interface Status Codes & Meanings		
Interface Status	Code for Log	Description of Status
To be coordinated	TBC	Both Contractors have not agreed the conditions for this interface
Coordinated	COR	Both Contractors have agreed that the interface is valid
Not coordinated	NCOR	One Contractor does not agree the conditions for this interface
Received	REC	The Contractor responsible for the design/construction element has received the information/documents required
Provided	PRO	The Contractor responsible for providing the information/documents to progress the design/construction element has provided the documents to the Interfacing Party
Accepted	ACP	The Contractor has accepted the proposed Interface Design or Construction element
Not Accepted	NACP	Either of the Contractors have not accepted the proposed Design/Construction element
Propose closeout	PCO	Both Contractors have accepted the proposed Interface Design or Construction element and no other requirements are outstanding. Both Parties have agreed to sign the Confirmation of Coordination Form
Closed out	CO	The final Interface Documentation together with Confirmation of Coordination Form has been sent to the Interface Coordination Manager for closing the interface
Superseded	SUP	The Interface design or construction element has been superseded

Attachment G – Confirmation of Coordination Form

Pune Metro					
Ref No.					
CONFIRMATION OF COORDINATION					
CONTRACT:				TRANSMITTAL No.:	
TITLE:					
ACTIVITY NO.:					
GENERAL DESCRIPTION:					
SIGNATURE OF INTERFACING CONTRACTORS:					
	Interfacing Contractor	Authorized Name	Signature	Date Reviewed	Comment
1					
2					
3					
4					
5					
<p>Signatures above confirm that this design document has been reviewed as part of the coordination process.</p>					
<p>NOTE: Where Contractors are not in agreement with the details on this submission, they are to comment above and advise the interfacing party in question requesting accommodation of the requirement and advise the Engineer under separate cover and report progress in Monthly Report / Coordination Meetings.</p>					

Attachment H - Guidance Notes for the Preparation of Interface Management Programme

1. The programme shall be prepared and submitted in bar chart format.
2. The bar chart shall be formed by activities grouped by major Zones of Interface.
3. The detail of each bar chart activity shall demonstrate the Contractor’s understanding of the scope of work of any Interfacing Contractor who is to supply input to the Contractor, in order for him to achieve an integrated coordinated design.
4. The bars shown on the bar chart shall be annotated with details of the information expected from the Interfacing Contractors, and highlight any target dates to receive or produce information.
5. Information relating to contractual milestone dates shall be shown on both the Contractor’s and Interfacing Contractors’ schedules.
6. The prime purpose of the document is to assist in ensuring that a coordinated design, construction, testing and commissioning is achieved. This document shall be forwarded to Interfacing Contractors for comment and agreement on a regular basis.
7. A complementary table of activities and dates should be prepared for ease of reference.

Attachment I - Guidance Notes for the Preparation of Interface Management Plan

The purpose of this Plan is to demonstrate how the Contractor proposes to achieve a fully coordinated design, which is compatible with that design carried out by Interfacing Contractors.

This document shall describe each of the component parts, within Zones of Interface, of the design, which require input from Interfacing Contractors. The descriptions should include details relating to the inputs required from both the Contractor and Interfacing Contractor, to achieve a fully coordinated design. The document should also be complementary to the IMPG, which details the proposed schedule and timings of each of the interfacing activities.

This document shall also detail the proposed interfacing requirements to be met by all Interfacing Contractors. The Contractor shall ensure that this document is acceptable to the Interfacing Contractors and that they are able to comply with all of its requirements. This is to be achieved by document exchanges and discussions to achieve agreement of documents.

The Plan shall therefore:

- i) Detail each of the component parts of the Project, which require the input of Interfacing Contractors to achieve a coordinated design. It shall describe the various disciplines and detail the technical input from others that will be required to achieve a coordinated design.
- ii) Cover the whole duration of the Works and be complementary to the IMPG, which details the proposed/agreed schedule and timings.
- iii) Be given by the Contractor to other Interfacing Contractors for their information and agreement.
- iv) Be developed in association with the process of increasing knowledge of the design and shall reflect the agreements reached by the Contractor and the Interfacing Contractors as the Project progresses. The Plan shall be updated on a quarterly basis to reflect this developing status.

The Status of any interface at any point in time shall be identified by one of the following conditions;

- to be coordinated
- coordinated
- not coordinated
- received
- provided
- accepted
- not accepted
- propose close-out
- superseded
- closed out

Maha Metro



Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

**Appendix 20 – Occupational, Health, Safety And
Environmental**

June 2018

1. Scope

- 1.1 The Employer's Requirements OHS&E Volume 1 (Appendix-20) details the requirements of the Employer for Safety, Health and Environmental control measures associated with the Contractor and any other agency, to be practiced on all Pune Metro Rail Limited construction sites or associated premises.

1.2 Application of this document

- 1.2.1 The Employer's Requirements, OHS&E Volume 1 applies to all aspects of the Contractor's scope of work, including that conducted by their appointed sub-Contractor and other agencies on their behalf. There shall be no activity associated with the Pune Metro underground section - Agriculture College to Swargate which is exempted from the purview of this document. This Volume 1 is supplemented with a further 2 OHS&E Volumes for ease of reference (Document, Section XIV). Their individual scope and applicability is as follows;
- 1.2.2 OHS&E Volume 1 is the controlling document for all Contracts and is fixed throughout the term of the project. Compliance with OHS&E Volume 1 is mandatory.
- 1.2.3 OHS&E Volume 2 (Reference Document, Section XIV) provides Safety & Health guidance that the Contractor may choose to use unless stated as mandatory within Volume 1. The contents of OHS&E Volume 2 remain subject to revision by the Engineer in the event of new Legislation or changing circumstances. The information contained within Volume 2 shall be used by the Engineer in assessing the sufficiency and suitability of the Contractor's management systems and performance.
- 1.2.4 OHS&E Volume 3 (Document, Section XIV) provides Environmental guidance and procedural requirements for the project. Volume 3 remains subject to periodic revision and updating.

1.3 Purpose of this document

The purpose of this document, the Employer's Requirements, OHS&E Volume 1 is to provide Contractors and other interested parties with the mandatory requirements relating to Health, Safety and the Environment practices and performance expectations on the Pune Metro underground section - Agriculture College to Swargate .

This document:

- a) Describes the OHS&E interfaces between the Employer, Engineer and the Contractor;
- b) Details the processes by which the Contractor shall manage OHS&E issues while carrying out the works under the contract and;
- c) Describes by reference, the practices, procedures and requirements pertaining to the Pune Metro underground section - Agriculture College to Swargate.

1.4 Pune Metro Rail Limited OHS&E Objectives

Pune Metro Rail Limited has identified five principle objectives for attainment during the Pune Metro underground section - Agriculture College to Swargate . These long term objectives shall be supported with quarterly, short and medium term objectives to enable structured advancement in overall performance. Our Short and medium term objectives also aims to facilitate

effective monitoring and measurement to identify where a directional change may be necessary. Our Long term objectives are:

To eliminate or minimize the unwanted effects of hazards and risks to personnel, members of the public and other stakeholders who may be exposed to the undertakings associated with the construction of the Pune Metro underground section - Agriculture College to Swargate Establish an effective and robust OHS&E management system that will enable Contractors to achieve international recognition and registration to the BS EN 18001:2007 Series.

1. Actively contribute to Contractors development through support, encouragement, determination in control and transfer of knowledge and skills in order to make the move from traditional compliance driven management through to risk managed processes.
2. To simplify the risk concept, to ensure a sensible approach to risk management and simplify hazard awareness training through adoption of the ALARP (As low as reasonably practicable) principles.
3. To practice 'Best Practice' within the construction industry - Establishing a work environment that conforms to international health & safety standards and make recommendation to improve effectiveness of regulations both nationally and locally.

2 Reference publications

BS EN ISO 9000:2005 - Quality management systems — Fundamentals and vocabulary

BS EN ISO 9001:2008, Quality management systems — Requirements

BSENISO 14001:2004, Environmental management systems — Requirements with guidance

BS EN ISO 19011:2002, Guidelines for quality and/or environmental management systems auditing

BS OHSAS 18001:2007, Occupational health and safety management systems Requirements

BS OHSAS 18002, Occupational health and safety management systems – Guidelines for the implementation of BS OHSAS 18001

PAS 99, Specification of common management system requirements as a framework for integration

International Labour Organization: 2001, Guidelines on occupational health and safety management systems — ILO-OSH 2001

Health & Safety Guidance (HSG) Health and Safety Executive publications United Kingdom

3 Terms and definitions

Acceptable risk. Risk that has been reduced to a level that can be tolerated by the organization having regard to its legal obligations and its own OHS&E policy

Accident. Incident giving rise to injury, ill health or fatality

ALARP (As low as reasonably practicable) principles.

Audit. Systematic, independent and documented process for obtaining “audit evidence” and evaluating it objectively to determine the extent to which “audit criteria” are fulfilled

BOCWA. Building and Other Construction Workers (Regular Employment and Conditions of Service) Act, 1996

BOCWR. Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Central Rules, 1998

BOCWWCA means Building and Other Construction Workers’ Welfare Cess Act, 1996

BOCWWCR means Building and Other Construction Workers Welfare Cess Rules 1998

MBOCWR means Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2003

Chief Safety Expert. An officer nominated by NMRL who is the overall responsible for monitoring all OHS&E functions prescribed in this document.

PMRL. Pune Metro Rail Limited

CIIBC means Chief Inspector of Inspection of Building and Other Constructions of Government of Maharashtra

Competent person. Person with the appropriate combination of skill, knowledge, qualifications and experience
Continual improvement. Recurring process of enhancing the OHS&E management system in order to achieve improvements in overall OHS&E performance consistent with the organization’s OHS&E policy

Corrective action. Action to eliminate the cause of a detected nonconformity or other undesirable situation

Design Risk Assessments. Used to record the actions of designers when reducing risks in construction and for future repairs and maintenance issues.

DG means Director General of Ministry of Labour, Govt. of India.

Employer. Pune Metro Rail Limited (PMRL).

Hazard. Source, situation, or act with a potential for harm in terms of human injury or ill health, or a combination of these

Hazard identification. Process of recognizing that a hazard exists and defining its characteristics

Health surveillance. Monitoring health of employees to detect signs or symptoms of work-related ill health so that steps can be taken to eliminate, or reduce the probability of, further harm

HIRA means Hazard Identification and Risk Assessment

Ill health. Identifiable, adverse physical or mental condition arising from and/or made worse by a work activity and/or work-related situation

Incident. Work-related event(s) in which an injury or ill health (regardless of severity) or fatality occurred, or could have occurred. An accident is an incident which has given rise to injury, ill health or fatality. An incident where no injury, ill health, or fatality occurs may also be referred to as a “near-miss”, or “dangerous occurrence”.

Interested party. Person or group, inside or outside the workplace, concerned with or affected by the OHS&E performance of an organization

Nonconformity. Non-fulfilment of a requirement; A nonconformity can be any deviation from: relevant work standards, practices, procedures, legal requirements, etc. or OHS&E management system requirements. Nonconformity

can be any deviation from: — relevant work standards, practices, procedures, legal requirements, etc. — OHS&E management system criteria.

Notifications (Central and state) – collection of cess.

OHS&E management system. Part of an organization's management system used to develop and implement its OHS&E policy and manage its OHS&E risks. A management system is a set of interrelated elements used to establish policy and objectives and to achieve those objectives. A management system includes organizational structure, planning activities (including for example, risk assessment and the setting of objectives), responsibilities, practices, procedures, processes and resources.

OHS&E objective. OHS&E goal, in terms of OHS&E performance that an organization sets itself to achieve.

OHS&E performance. Measurable results of an organization's management of its OHS&E risks

OHS&E policy. Overall intentions and direction of an organization related to its OHS&E performance as formally expressed by top management

Preventive action. Action to eliminate the cause of a potential nonconformity as explained in this clause 3 – term and definitions or other undesirable potential situation

Procedure. Specified way to carry out an activity or a process

Record. Document stating results achieved or providing evidence of activities performed

Risk. Combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of injury or ill health that can be caused by the event or exposure(s)

Risk assessment. Process of evaluating the risk(s) arising from a hazard(s), taking into account the adequacy of any existing controls, and deciding whether or not the risk(s) is acceptable

Risk control. Selection and application of suitable measures to reduce risk

Shall. Indicates a mandatory requirement within this document

Stakeholders. Those with a interest in an organization's achievements that includes, but is not limited to, internal and "outsourced" employees, customers, suppliers, partners, employees, distributors, investors, insurers, shareholders, owners, government and regulators.

Status review. Formal evaluation of the OHS&E management system

Top management. Person or group of people who direct and control an organization at the highest level

Worker representative. Representative of employee occupational health and safety

4 SHE management system requirements

4.1 General requirement

- 4.1.1 The Contractor shall define and document the scope of its Occupational Safety Health and Environmental (OHS&E) management system to meet legal requirements and the requirements of Pune Metro Rail Limited as stated within this document.
- 4.2 The Contractor's OHS&E management system shall determine how the organisation shall document, implement, maintain and continually improve upon performance in accordance with the requirements of the International OHSAS Standard to which the Employer is committed

PMRL OHS&E Policy Statement of Intent

Pune Metro Rail Limited consider that health, safety and environmental is of equal importance in comparison to any other aspect of business management and as such is committed to promoting high standards of safety, health, environment and welfare on all of their sites and premises. To achieve this Pune Metro Rail Limited shall:

- Constantly work towards improving the safety culture at all levels.
- Ensure compliance with all relevant legal duties in respect of health and safety at work legislation.
- Provide adequate resources for planning and controlling working conditions and safe systems of work.
- Work with our Contractors and suppliers to improve their safety performance, by Measuring and monitoring their performance.

Responsibilities and performance requirements for Safety, Health and the Environment are summarised as follows: -

- All Contractors, employees, sub-Contractors, consultants, suppliers and visitors have a duty to play an active role in achieving our objectives through compliance with their legal obligations and this Safety Policy.
- Participation and consultation are vital aspects of this Policy and to the achievement of our objectives. Contractors and Staff are encouraged and expected to:
- Discuss safety, health and welfare matters with their managers, and company Safety, Health & Environmental Representatives who will offer or obtain further expert advice, where necessary.
- Co-operate at all times; contribute good ideas and improvements; report defects and short falls.

The correction of any breach of statutory provision or Pune Metro Rail Limited requirements on health and safety shall take priority. Should appropriate action not be taken to meet the required standards, this will be taken seriously and may lead to disciplinary action being taken.

This Policy Statement shall be displayed prominently on all Pune Metro Rail Limited sites and offices and will be kept under review to ensure its relevance

Managing Director
Pune Metro Rail Limited

4.3 Planning

4.3.1 Hazard identification, risk assessment and determining controls

4.3.1.1 The Contractor shall submit a procedure detailing the process in place for the identification of Hazards and Risks and the determination of control measures including the relevant standards as per clause 4.4.4.1 and 4.3.2.3 of this controlled document. The Procedure shall incorporate the Employer's Requirements within this and other applicable OHS&E Volumes.

4.3.1.2 Management of Change

All temporary and permanent changes to organisational, personnel, systems, procedures, equipment, products, materials or substances shall be evaluated by the Contractor and managed to ensure that health, safety and environmental risks arising from these changes remain at an acceptable level. Changes made by the Contractor are subject to submittal and notice of no objection by the Engineer prior to adopting change.

4.3.1.3 Risk Register & Hazard Log

- 1) The Contractor's Construction Health and safety Plan shall contain a detailed 'Risk Register' and 'Hazard Log' specific to the project. The register and log shall be assessed against the NMRL OHS&E requirements Volume 2.
- 2) The Hazard Log shall identify future method statement, risk assessment and operational procedures pertaining to specific equipment and operations in relation risk and local environmental constraints. Construction phase OHS&E Plans shall not be accepted without a fully completed Hazard Log and Risk Register.

4.3.1.4 Method Statements

- 1) Method statements are to be submitted to the Engineer a minimum of 21 days prior to task commencement to ensure sufficient time is available for review and notice of no objection.
- 2) Method statements shall contain the information requirements as prescript within the NMRL OHS&E Volume 2.
- 3) Method statements shall incorporate the control measures within the process methodology as identified within the risk assessment.
- 4) A copy of the relevant method statement for the activity being undertaken shall be available on site for reference by all site management and supervisors.

4.3.1.5 Risk Assessment production & submittal

- 1) Risk assessments shall contain as a minimum, the information as specified within the NMRL OHS&E Volume 2. The Contractor may choose to use their own format however the risk tolerances, probability and consequences must be included.
- 2) Risk assessments shall be produced and submitted to the Employer's a minimum of 21 days prior to task commencement for notice of no objection. Risk assessments may be submitted independently or as part of a Method Statement.
- 3) Generic risk assessments other than routine activities of low risk shall not be accepted by the Employer.

Risk assessments shall be regularly reviewed to ensure they remain suitable and sufficient. Risk assessment reviews shall be undertaken where an incident has occurred and when a change in location may introduce additional risks from construction activities.

- 4) Substances hazardous to health shall be subject to assessment by the Contractor. Where Hazardous substances are identified for use within a process the assessment and determining controls shall be included within the relative method statement.

4.3.1.6 Design Risk Assessment

- 1) Design Risk Assessments shall be submitted to the Engineer for granting of Notice of no objection. Design risk assessments shall accompany all drawing submittals for operations involving;
 - Temporary works,
 - Formwork & false-work
 - Heavy lifting equipment.
- 2) Drawings shall not be accepted by the Engineer without an accompanying design risk assessment.

4.3.2 Legal and other requirements

4.3.2.1 Contractor shall comply with all legal obligations and the requirements of Pune Metro Rail Limited as contained herein.

- a) Contractor shall develop thorough understanding about Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996, Central Rules 1998, The Building & Other Construction Workers Welfare Cess Act 1996 and Central Welfare Rules 1998, Maharashtra Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2003, Building and Other Construction Workers Welfare Cess act 1996 and Central Rules 1998, Notification [Central & State] – Collection of Cess, not only to satisfy the Inspectors' perspective but the use of legislation as the strong tool for effective SHE management at construction worksites. Contractor is strongly advised to practice the principle of voluntary compliance.
- b) In order to facilitate the Contractor for better understanding on the various provisions of the above Act and Rules, a tabulated information highlighting the Sections/Rules referring to the corresponding registration of Contractors, maintenance of registers and records, hours of work and wages, cess & welfare, medical facilities and safety requirements are given in Appendix No. 1. It is an indicative one and not a limiting list.

4.3.2.2 Indian statutory requirements

The Contractor shall abide by all national, state and local bye-laws. It is the duty of the Contractor to ensure that all Sub-contractors appointed also comply with their legal obligations as listed below but not limited to:

- i. Indian Electricity Act 2003 and Rules 1956
- ii. National Building Code, 2005
- iii. Factories Act, 1948,
- iv. Motor Vehicles Act as amended in 1994, The Central Motor Vehicles Rules, 1989.

- v. Indian Road Congress Code IRC: SP: 55-2001 'Guidelines on Safety In Road Construction Zones.
- vi. Indian Road Congress Code IRC: SP: 55-2001 'Guidelines on Safety In Road Construction Zones'
- vii. The Petroleum Act, 1934 and Rules 1976
- viii. Gas Cylinder Rules, 2003
- ix. Indian Explosives Act. 1884, along with the Explosives substance Act 1908 and The explosives Rules 1983
- x. The (Indian) Boilers Act, 1923
- xi. The Public Liability Insurance Act 1991 and Rules 1991
- xii. Minimum Wages Act, 1948 and Rules 1950
- xiii. Contract Labour Act, 1970 and Rules 1971
- xiv. Child Labour (Prohibitions & Regulations) Act, 1986 and Rules 1950
- xv. Environment Protection Act, 1986 and Rules 1986
- xvi. Air (Prevention and control of Pollution) Act, 1981
- xvii. Water (Prevention and Control of Pollution) Act, 1974
- xviii. The Noise Pollution (Regulation & Control) Rules, 2000
- xix. Notification on Control of Noise from Diesel Generator (DG) sets, 2002
- xx. Recycled Plastic Usage Rules, 1998
- xxi. Notification, Central Ground Water Board, Act January 1997
- xxii. Manufacture, Storage & Import of Hazardous Chemicals Rules, 1989
- xxiii. Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996
- xxiv. The Hazardous Waste (Management & Handling) Rules, 1989
- xxv. Hazardous Waste Management Rules 1989 (as amended in 1999)
- xxvi. Batteries (Management and Handling) Rules
- xxvii. Fly ash utilization notification, Sept 1999 as amended in August 2003
- xxviii. Workman Compensation Act, 1923 along with allied Rules
- xxix. Guidelines of Pune Urban Development Authority
- xxx. Guidelines of Maharashtra Pollution Control Board

4.3.2.3 International Standards, Guidelines & ISO Certifications

- 1) If the requirements stated in this document are in conflict or inconsistent with the requirements of applicable laws, the more stringent requirements shall apply.
- 2) The Contractor complies with norms, standards and discharge limit values recommended by the specialized international organizations affiliated to the United Nations, as described in the item 3 below.
- 3) The specialized international organizations affiliated to the United Nations referred to in Clause 9.2 include:
 - World Bank, including the IFC and its Environmental, Health and Safety guidelines available from <http://www.ifc.org/ehsguidelines>

For matters not addressed in the IFC above document, the norms, standards and

discharge limit values of the following institutions shall apply:

- World Health Organization (WHO)
 - International Labour Organization (ILO) (in particular in pursuance to Clauses 6.20, 6.21, 6.23 and 6.24 of the GCC)
 - International Maritime Organization (IMO)
- 4) The works shall be undertaken in accordance with the applicable international guidelines, standards and specifications on OHS&E and every Contractor shall actively pursue the achievement of:
- BS EN OHSAS 18001:2007 - OHS Management Systems
 - ISO 14001-2004: Environmental Management Systems
- 5) The process of international certification to BS EN 18001:2007 and ISO 14001-2004 standard shall commence immediately after the award of Contract through appointment of ISO accrediting body for obtaining the certification. Should this not be undertaken by the Contractor within 3 months of the Contract award, the Engineer shall appoint at the Contractor's cost.
- 6) Should the Contractor already possess such certification, the scope of the Pune Metro Project must be included on the Contractor's certification within 1 year of Contract commencement and proof of such attainment demonstrated to Pune Metro Rail Limited.

4.3.3 Objectives and programme(s)

- 4.3.3.1 The Contractor shall maintain procedures to establish detailed OHS&E objectives and performance criteria. Such objectives and performance criteria shall be developed to incorporate the Pune Metro Rail Limited policy and strategic OHS&E objectives. The Contractor's objectives shall be quantified, wherever practicable, and identified with defined timescales. The Contractor is required to submit for notice of no objection their procedure and objectives as per clause 4.4.4.1 of this control document.

4.4 Implementation and operation

4.4.1 Resources, roles, responsibility, accountability and authority

- 4.4.1.1 The Contractor shall detail within the Construction Health, Safety and Environmental Plan the planned roles and resources allocated for the PMRL project. In addition to the staffing arrangements the Contractor shall prescribe the responsibilities specific to role, accountability and the authority under which they operate.
- 4.4.1.2 Safety, health & environmental resources shall be provided by the Contractor as per the Contract value in table – 1

Table 1 Mandatory Contractor OHS&E management resource requirement

	1	2	3	4	5	6
Contract Value in (Cr.)	Chief OHS&E Manager	Senior OHS&E Manager	Junior OHS&E Manager	Safety Steward	Senior Electrical Engineer	Junior Electrical Engineer
Up to 2	-	-	1	Refer to note 1	-	1
Up to 10	-	1	Refer to note 1		1	Refer to note 2
Up to 25	1	Refer to note 1			1	
Up to 100	1				1	
Up to 250	1				1	
250 or Mor	1					1

	7	8	9
Contract Value in (Cr.)	*Junior SHE (Fire) Manager/ ** Senior SHE (Fire) Manager	Occupational Health Officer with necessary nursing assistants (Refer note 3)	Environmental Manager
Up to 2	-	-	-
Up to 10	-	1 (PT)	1
Up to 25	1*	1 (PT)	1
Up to 100	1*	1 (FT)	1
Up to 250	1**	2 (FT)	1
250 or Mor	2 **	2 (FT)	1 with support staff

Notes :

- 1) Qualified and trained OHS&E Professionals as per Table 2 with required support staff to be deployed at each worksite at each shift. Qualification of appointed OHS&E personnel shall be in accordance with Section 4.4.2 competence, Awareness and Training within this document
- 2) Qualified and trained Electrical Engineers/supervisors to be deployed at each worksite for each shift.
- 3) PT means Part Time and FT means Full Time
- 4) Senior SHE (Traffic) Engineer Post and Barricade Manager (including the staff) Posts are applicable to contracts where the work has to be executed either below or over the right-of-way like Viaduct, Tunnel Contracts wherein erection and maintenance of barricades are paramount important.
- 5) One Barricade Manager supported by required supervisors and workmen

- 6) One Housekeeping Manager supported by required supervisors and workmen.
- 7) The Contractor appoints a person responsible for relations with external stakeholders for the site: local communities, administrative authorities, and representatives of economic activities located within one hour travel from the Worksite. This person will be based on the Worksite on a permanent basis. Administrations and local authorities will be informed of the existence of this person as of the start of works and will be provided with telephone contact details so as to be able to contact this person if a problem arises during the execution of works or concerning the behavior of the Contractor's employees outside the Worksite.

4.4.1.3 Responsibility

- 1) The General Manager of the Contractor is responsible and accountable for compliance with the conditions and clauses within this document.
- 2) The General Manager is responsible to ensure that the necessary resources are allocated and made available to meet the requirements as laid out within this document and other referenced materials to include Legal Requirements (as mentioned in clause 4.3.2).
- 3) For all works carried out by the Contractor and appointed Sub-contractor's, the responsibility for ensuring OHS&E resources remains with the main Contractor. Activities undertaken by the Contractor's Sub-contractors shall be monitored by the Contractor at all times to ensure compliance with agreed safe systems of working.
- 4) All Contractor's OHS&E personnel shall report to the Chief OHS&E Manager who shall report directly to the General Manager or Corporate Safety Director of the Contractor's organisation. This shall be reflected in the Contractor's organisation charts within the OHS&E plan and Quality Management Plan.
- 5) The Employer shall monitor adherence to the provisions of Table 1. Where deviation is evident this shall be recorded as a non-conformance.
- 6) The Contractor shall provide all OHS&E personnel with such facilities, equipment and information that are necessary to enable them to dispatch their duties effectively.
- 7) The Contractor's Safety Managers, Safety Advisors and Officers are responsible for ensuring that reports on the performance of the OHS&E management system are presented to top management for review and used as a basis for improvement of the OHS&E management system.
- 8) The Contractor's Safety Managers, Safety Advisors and Officers are responsible for independently monitoring the operations of the Contractor, where deficiencies are identified they are responsible to report their findings immediately to the Site Engineer in charge who then must take action as directed.

4.4.1.4 Accountability

- 1) In cases where the Contractor fails to provide the minimum required manpower as illustrated in Table 1, or fails to fill vacancies created within 30 days, the same may be provided by the Engineer at the Contractor's cost. Any administrative expenses involved in providing the same for example, vacancy advertisements or recruitment consultant charges, shall also be at the cost of Contractor.

- 2) No OHS&E personnel shall be permitted to do any work which is unconnected to, inconsistent with or detrimental to the performance of the OHS&E duties.
- 3) Supervisors must ensure that the employees under their direct supervision are working in compliance with the approved safe systems of working.

4.4.1.5 Authority

- 1) The Contractor's Safety Managers, Safety Advisors and Officers authority shall be stated within the Construction Health and Safety Plan and the authority level must be communicated to all Contractor's Staff including Sub-contractors.
- 2) The Contractor's Safety Managers, Safety Advisors and Officers shall have the authority as assigned by the General Manager to suspend works where deviation from an approved method of working occurs that presents a risk of injury, equipment or property damage.
- 3) The Engineer shall have the right to stop the work if in his opinion the work is being carried out in such a way that a risk of injury, property and or equipment damage may exist. The Contractor shall not proceed with the work until remedial works have been completed with under the direction and satisfaction of the Employer. Should the Contractor continue to work without implementing the Engineer's instruction, clause 4.4.2.2 shall be applied to the individual responsible for the decision to proceed.
- 4) The Contractor shall not be entitled to any damages or compensation for stoppage of work, due to safety reasons. The period of such stoppages of work shall not be taken as an extension of time for completion of the facilities and will not be the ground for waiver of levy of liquidated damages.

4.4.2 Competence, training and awareness

4.4.2.1 The Contractor shall ensure that the recruitment, selection and placement processes shall be in place to ensure that personnel are qualified, competent, and physically fit for assigned tasks. The Contractor shall produce a procedure that shall be made available to the Engineer for notice of no objection as per Clause 4.4.4.1.2 of this document. The procedure shall define the processes in place to ensure competence.

4.4.2.2 The Contractor's attention is drawn to Part 3 General Conditions Clause 6.9 (d), whereby any person employed thereon, who in the opinion of the Engineer, misconducts himself or is incompetent or negligent or fails to conform with any particular provisions with regard to safety, health or environment which is set out in the Contractor's OHS&E Plan or a requirement of the Contract, or persists in any conduct which is prejudicial to safety or health, shall be removed from site immediately, and such persons shall not be employed again upon the Works. The decision of the Engineer in this regard shall be final.

4.4.2.3 Notice of No Objection from the Engineer

- 1) The name, educational qualifications and work experience for all persons intended for a Contractor's OHS&E role shall be submitted to the Engineer for notice prior to employment. Only upon notice of no objection by the Engineer shall OHS&E personnel be authorised to work on a PMRC site.
- 2) No Contractor shall engage SHE manpower from any outsourcing agencies

in which case the effectiveness would be lost. All SHE manpower shall be on the payroll of the main Contractor only and not on the payroll of any subcontractor or outsourcing manpower agencies etc. This condition does not apply to positions like traffic marshals who are engaged almost on a daily requirement basis.

- 3) All SHE personnel are to report to the Chief SHE Manager who shall report directly to the Chief Project Manager. The Employer shall monitor adherence to this procedure at all times. In case of non-adherence penalty shall be levied as indicated in the penalty clause.
- 4) The minimum Employer's requirements of such facilities / equipment's to be provided for SHE personnel are given in table below.
- 5) The Contractor shall appoint the required OHS&E personnel in accordance with the qualifications and experience as listed in table – 2

Table 2 OHS&E Personnel Qualifications & Experience

Item	Designation	Qualification	Experience (Years)
1	Chief OHS&E Manager	The Chief OHS&E Manager shall be qualified in any of the following degrees/diplomas: Post Graduate Diploma in Industrial Safety & Environmental Management (PGDISEM) M.E. in Industrial Safety from NIT, B.E. in Fire and Safety Engg. B.E. with advanced Safety Management Diploma B.E / B.Arch., with one year <u>Full Time</u> advanced Safety diploma B.E/B.Tech full time Degree / Diploma in Safety. International qualifications, CSP (Certified Safety Professional), NEBOSH, MIOSH, MSISO etc	15
2	Senior OHS&E Manager	As stated in Sl. No:1 and in addition the following categories: i) B.Sc.(Physics/Chemistry/Maths) with one year Full Time advanced Safety diploma ii) B.Sc. / Diploma in Engg. with advanced safety Management Diploma iii) B.Sc. (Physics/Chemistry/Maths) with One year Full Time diploma in Safety Engineering iv) Any Graduate or diploma holder with 7	2 years for category (i) (ii) and (iii)

3	Junior OHS&E Manager	i) Degree in Science / Diploma in Engineering with Govt. recognized safety diplomas ii) Any Graduate or diploma holder with <u>5 years</u> of work experience in a OHS&E department with prior approval of Engineer (on a case to case basis)	i) 2 Years
4	Safety Steward	Any basic qualification with any OHS&E related certificate courses.	2 Years
5	Senior Electrical Manager	Degree in Electrical Engineering + Govt. Recognized Electrical Licence holder	2 Years
6	Electrical Manager	Diploma in Electrical Engineering + Govt. Recognized Electrical Licence holder	1 Year
7	Senior SHE (Fire) Manager	i) B.E. (Fire) from National Fire Service College, Pune ii) B.E (Fire & Safety) from Cochin University Graduate with any Govt. recognized diploma in Fire Safety with 5 years of experience	2 (for category (i) and (ii) only)
8	Junior SHE (Fire)	Any Diploma holder with any Govt. recognized diploma in Industrial Fire Safety.	1 Year
9	Occupational Health Officer	MBBS with Govt. recognized degree/diploma in Industrial/ occupational health	1 Year
10	Environmental Manager	Govt. recognized PG Degree / PG Diploma / Degree in Environmental Engineering / Science	2 Years
11	Senior Traffic Engineer	Govt. recognized PG Degree / Degree / Diploma in Traffic/Transportation Engineering or Planning	1 Year
12	Housekeeping Squad Manager & Barricade Manager	Any Diploma in Engineering	1 Year
13	Labour Welfare Officer	Any degree with Govt. recognized Degree / Diploma / P. G. Diploma in labour welfare related fields like Law, Personnel/Industrial Relations etc.	1 Years

- 6) In case if the Contractor fail to provide the minimum required manpower as illustrated above or fail to fill up vacancies created within 14 days, the same shall be provided by the Employer at Contractor's cost. Any administrative expenses involved, providing the same like paper advertisement or manpower consultant charges, etc shall also be at the cost of Contractor.
- 7) Where a potential candidate has previously worked in a Metro Rail construction environment and does not possess the qualifications and or the necessary experience as listed in Table 2 for the particular role, the Engineer may upon a successful interview of the candidate grant a waiver

subject to successful completion of a probation period of 3 months.

- 8) In order to effectively interact on labour welfare matters with the Engineer and the statutory authorities enforcing the labour welfare legislations every Contractor shall employ a full time Labour Welfare Officer duly qualified and experienced as per clause

4.4.2.4 OHS&E Induction Training

- 1) The Contractor shall ensure that all personnel (Workers/Staff/Employees/Sub- Contractors and their personnel) working at the site receive an induction OHS&E training of at least 2 weeks (96 hrs) explaining the nature of the work, reporting & communication routes the hazards that may be encountered during the site work and the particular hazards attached to their own function within the operation. The training shall cover as a minimum the contents as directed within OHS&E Volume 2 (refer – Part 4, Section XIV).
- 2) Records of all inductions shall be maintained by the Contractor and be made available for inspection by the Employer upon request.
- 3) The Contractor shall provide their workforce and management staff with an OHS&E induction Handbook containing the information as per the induction training.
- 4) A condensed induction shall be given by the Contractor to all visitors. The induction briefing shall include the risk and hazards associated with the particular site and the operations being conducted.
- 5) All personnel shall be issued a temporary ID upon the completion of the Contractor's' induction. The temporary ID shall be signed by the Human Resource Manager or appointed representative and limited to a 2 week validity period at which time the temporary ID shall be replaced with a permanent ID including photograph.
- 6) Individuals found on site by the Engineer without-dated temporary ID cards shall be removed from site

4.4.2.5 OHS&E Training

- 1) The Contractor shall assess the training requirements for all the employees, plan and initiate a training program to fulfil the training needs assessment. The assessment of training needs shall incorporate all levels of staff including Sub-contractor's against an individual's role, responsibility, ability, language skill and risk.
- 2) The Contractor shall produce a 'Training Implementation Plan' to incorporate the findings of the needs assessment.
- 3) The training needs assessment together with Implementation Plan shall be submitted to the Engineer for notice of no objection within 4 weeks of commencement. The Engineer shall evaluate the assessment and plan against the base line training matrix contained within OHS&E Volume 2 (Reference Document, Section XIV).
- 4) Records of all training conducted shall be maintained and made available for inspection by the Engineer upon request. Should the Contractor fail to provide the training identified within the Contractor's assessment, implementation plan and the Engineer's Training matrix within the agreed

timescales, this shall be reflected in the potential scores awarded within the monthly audit report.

- 5) 4.4.2.4.6 Specific training with regard to the provisions of the Construction Safety Plan, and associated operational and system procedures shall be conducted by the Contractor for all persons with supervision responsibilities. Records of training including duration shall be maintained.

4.4.3 Communication, participation and consultation

4.4.3.1 Communication

- 1) The Contractor shall produce a 'High Quality' quarterly newsletter on a rotational basis with other Contractors. Rotation shall be announced within the Engineer's OHS&E Committee meetings.
- 2) All Contractors including the Engineer shall provide input into the rotational Contractor for the newsletter content such as details of accidents, incidents and near misses together with any lessons learned; specific safety initiatives; internal competitions and workforce awards etc.
- 3) The Engineer shall be issued the draft newsletter for review prior to the Contractor's publishing.
- 4) The OHS&E Newsletters shall publicize all Contractors OHS&E performances over the previous 3 months in relation to OHS&E Audits and shall form the basis for the Engineer's Awards programme. Results of audits shall be provided by the Engineer for inclusion.
- 5) The quarterly newsletters shall be issued to all interested parties and be promulgated at site level. Where language barriers exists the contents of the newsletters shall be communicated by the Workforce Representative to ensure understanding.
- 6) At site level the Contractor shall erect pertinent awareness signage and posters. Posters shall be changed on a monthly basis to maintain impact.
- 7) Poster campaigns shall be discussed and agreed at the Engineer's Committee Meeting to maintain a consistent improvement programme across all NMRL Sites.
- 8) Informational posters, banners etc shall be provided in Marathi, Hindi and English.
- 9) Toolbox talks or team briefings shall be carried out daily by the Contractor and correspond to the works activities being undertaken or to communicate a specific awareness initiative. Toolbox talks shall not replace professional training.
- 10) Records of all toolbox talks undertaken together with the date, topic, participant's names and signatures shall be maintained and made available for inspection by the Engineer.
- 11) Method statement and risk assessment briefings shall be carried out prior to the commencement of a new task and or when a change to the method of working arises. Records of all such briefings shall be maintained by the Contractor.
- 12) Visitor information signage shall be posted at site entrances detailing where to report and contact information.

Note: visitors shall be accompanied at all times by site security where office

locations require walking through operational areas.

- 13) Public Liaison
- 14) Public informational signage and Contractor contact information shall be posted externally to the site.
- 15) The Contractor shall appoint an individual as a Public liaison Officer to communicate directly with members of the public regarding forthcoming operations, what to expect, noise expectancy, duration of operations etc.

4.4.3.2 Participation and consultation

- 1) The Contractor shall establish a Safety Committee within 4 weeks of commencement that shall be chaired by the Contractor's Project Manager.
- 2) The Contractor shall notify the Engineer of the establishment of the Committee together with the committee members' names and designation. The Contractor's Chief Safety Manager, Senior Safety Manager, Plant & procurement Manager and Human Resources Manager shall form the minimum committee members. Site based personnel shall be represented within the Committee by the attendance of Site Manager(s) and the Workforce OHS&E Representative.
- 3) The Engineer shall be invited to attend the Contractor's Safety Committee meetings.
- 4) The Contractor's OHS&E Committee shall meet on a monthly basis throughout the duration of the Contract.
- 5) The Committee shall review the previous month's performance, to include, inspections and audits undertaken, accidents and incidents and any concerns or complaints that have been raised. Short term objectives and targets for improvement shall be set for completion by the next scheduled Committee meeting.
- 6) The Safety committee shall undertake a formal site inspection to be scheduled on a 2 monthly basis. The inspection shall review progress regarding the achievement of short term targets. The Committee shall produce a report stating progress made together with any corrective actions required and issue to the Engineer within 7 days following the Inspection.
- 7) Minutes of the Committee meeting shall be issued within 2 days and promulgated to all members including the Engineer. The minutes of meeting shall also be posted on all sites within the workforce area. The minutes intended for site communication shall be in both Marathi\Hindi and English.

4.4.3.3 Engineer's OHS&E Committee

- 1) A Safety Health and Environmental Committee shall be established by the Engineer and shall sit every 3 months throughout the project period. All Contractors shall be required to attend the quarterly meetings who shall be represented by their General Manager and Chief Safety Manager.
- 2) The Committee shall review previous performances project wide and set short and medium term objectives and targets for achievement within the next reporting period.
- 3) The Engineer reserves the right to call an Emergency Meeting of the

Committee members in the event of a serious incident that requires immediate change to the operational methods of working.

- 4) Minutes of the Engineers OHS&E Committee shall be promulgated to all Contractor's within 3 days.

4.4.3.4 Workforce Representation

- 1) All workers shall have access to a Workforce OHS&E Representative who is responsible to communicate directly with the labour force with regard to safety and health. The representative's name and contact number shall be posted on all sites externally to the site office. The Workforce OHS&E Representative shall be made a member of the OHS&E Committee and attend all meetings.
- 2) The OHS&E Representative shall meet the labour force on a monthly basis to discuss health, welfare, safety initiatives and or concerns the workforce may have. Minutes are to be produced by the Representative and issued formally within 2 days after the meeting date to the Contractor's Project Manager, General Manager and Engineer
- 3) A lockable site suggestion box to which only the workforce OHS&E Representative shall have access shall be installed on all sites and within any labour accommodation camps. The suggestion box shall be located independent from any offices, in a public area and protected from bad weather. The OHS&E Representative shall inform the workforce that the purpose of the suggestion box is to provide a means of participation, communicating ideas and initiatives and also for raising concerns without fear of reprisal.
- 4) The contents of all suggestion boxes shall be collected and collated on a weekly basis. Where concerns or complaints regarding the standards of health, safety or welfare have been reported these shall be immediately reported to the Chief OHS&E Manager and Project Manager who shall investigate the concern(s). Records of such investigations and resultant outcomes shall be maintained.
- 5) Ideas, suggestions and concerns raised by the workforce during the OHS&E representative's on site monthly meetings shall form an agenda item within the Contractor's OHS&E Committee meeting.
- 6) Where an idea or specific suggestion is subsequently adopted for use by the Contractor's OHS&E Committee, the individual shall receive an OHS&E award as determined by the Contractor.
- 7) Where Employee awards are issued this shall be notified to the Engineer to ensure inclusion within the Quarterly Newsletter.

4.4.3.5 Contractor Awards

The Employer shall recognize the effort, participation and commitment demonstrated by the Contractor by nominating awards. The award type shall be at the discretion of the Employer.

4.4.4 Documentation

4.4.4.1 Management System procedures

- 1) The Contractor is required to submit for notice of no objection, the organisation's top tier Management System Procedures as listed in Table 3

that shall be adopted for use on the NMRL project.

- 2) System procedures shall be submitted to the Engineer within 4 weeks of commencement.
- 3) Construction works shall not commence until such time as a notice of no objection has been received; applicable to all management system procedures as listed in Table 3. Should the Contractor commence operations on site without notice, the Engineer shall award a 'Zero' audit score for every month of non-compliance with this clause.
- 4) The Engineer shall evaluate the suitability of the Contractor's system procedures against the BS EN 18001:2007 and ISO 14001:2004 standards
The submitted procedures shall be individually identified with a unique reference and detail in sequence the scope, purpose, referenced material and procedure processes.
- 5) Where such procedures as listed in Table 3 exist within other areas of the Contractor's organisational management systems such as quality management, these shall not be subject to replication if the procedure makes specific reference to Health, Safety and Environmental control.
- 6) Compliance standards against the Contractor's management system procedures shall be subject to audit by the Engineer.

Table 3 OHS&E Management System Procedures

Hazard identification, risk assessment and determining controls	Communication, participation & consultation	Environmental Impact Aspect Assessment	Objectives and programme(s)
Training, awareness and competence	Implementation and operation	Accident & Incident Investigation	Legal requirements
Documentation	Monitoring & Measurement	Emergency Preparedness	Change control
Procurement	Record keeping	Audit	Management review

4.4.5 Control of documents

- 4.4.5.1 All plans, procedures and method statements shall be controlled and subject to review and formal approval by the Contractor's Project Manager prior to issue to the Engineer.
- 4.4.5.2 All documents subject to review by the Engineer shall be signed by the Contractor's Project Manager and issued formally.
- 4.4.5.3 Documents shall be issued as per the Engineer's requirements regarding Quality Management.
- 4.4.5.4 OHS&E Documents shall be issued, maintained, traceable and available for retrieval pursuant to the Contractor's ISO accredited Quality Management System.

4.4.6 Operational control

- 4.4.6.1 Operational control shall be maintained through the implementation of the provisions stated within the Contractor's site specific Construction Health Safety and Environmental Plans, the contents of which are outlined in Safety, Health and Environmental Volumes 2 and 3 (Reference Document, Section XIV) to which the

Contractor shall comply.

4.4.6.2 Construction Phase Health & Safety Plan

- 1) The Contractor shall produce a Contract specific Construction Health & Safety Plan (CHSP) and submit to the Engineer within 28 days of commencement.
- 2) The Construction Health and Safety Plan shall contain the informational requirements as per the CHSP contents as prescript within the NMRL OHS&E Volume 2 (Reference Document, Section XIV), Safety Plan contents.
The CHSP shall be assessed by the Engineer against the provisions as stated within OHS&E Volume 2 (Reference Document,, Section XIV). Where deficiencies exist to an extent where an objection is raised, construction activities shall be suspended until such time as the deficiencies are subject to corrective action, re-submittal and notice of no objection by the Employer.
- 3) Delays incurred as a result of the Contractor failing to achieve a Notice of 'No objection' status from failing to submit within the specified timescale or non compliance with OHS&E Volume 2 shall be entirely at the Contractor's risk and cost.
- 4) The Contractor shall undertake a monthly review of the CHSP. The review shall be recorded and the Engineer notified of any updates.

4.4.6.3 Construction Phase Site Environmental Plan

- 1) The Contractor shall produce a Contract specific Site Environmental Plan (SEP) and submit to the Engineer within 28 days of commencement.
- 2) The Site Environmental Plan (SEP) shall contain the informational requirements as per the contents as prescript within the NMRL Environmental Management Arrangements Volume 3 (Reference Document,, Section XIV), Environmental Plan contents.
- 3) The SEP shall be assessed by the Engineer against the provisions as stated within the Environmental Management Arrangements Volume 3 (Reference Document,, Section XIV). Where deficiencies exist to an extent where an objection is raised, construction activities shall be suspended until such time as the deficiencies are subject to corrective action, re-submittal and notice of no objection by the Engineer.
- 4) Delays incurred as a result of the Contractor failing to achieve a 'Notice of No objection' status from failing to submit within the specified timescale or non compliance with Environmental Management Arrangements Volume 3 (Reference Document,, Section XIV) shall be entirely at the Contractor's risk and cost.
- 5) The Contractor shall undertake a monthly review of the SEP. The review shall be recorded and the Engineer notified of any updates.

4.4.6.4 Operational procedures

- 1) The Contractor shall identify within the Hazard Log and Risk Register the operational control procedures that shall be applicable for the NMRL project under their individual scope of works.
- 2) Operational procedures shall be submitted for review to the Engineer for notice of no objection together with the Construction Site Safety Plan within 4 weeks of commencement.

- 3) The operational procedures shall be evaluated by the Engineer against the requirements stated within OHS&E Volume 2 (Reference Document, Section XIV), international safety standards such as the International Labour Organisation, European Norms and British Standards where an equivalent Indian Standard does not exist.
- 4) Construction works shall not commence until such time as a notice of no objection has been received; applicable to all operational procedures as identified within Table 4 and the Contractor's Hazard Log & Risk Register. Should the Contractor commence operations on site without notice, the Engineer shall award a 'Zero' audit score for every month of non-compliance with this clause.
- 5) The submitted procedures shall be individually identified with a unique reference and detail in sequence the scope, purpose, referenced material and procedure processes.
- 6) In the event that the Contractor is unable to comply with the 28 day timeframe for submittal of the minimum operational procedures as detailed within Table 4, the Contractor shall assign an individual identification reference for the outstanding procedure within the Construction Health, Safety & Environmental Plan together with the statement 'Under process'. The 'Under Process' procedure shall be required to be submitted for notice of no objection a minimum of 28 days prior to commencement of any activity that involves the application of the procedure.

Table 4 Operational Procedures

Lifting Operations & Lifting	Plant & Equipment	Occupational Health provisions	Emergency Medical Facilities & First Aid
Personal Protective Equipment	Permit to Work Systems	Site Electricity & Distribution	Welding & Cutting operations
Incident Investigatio	Traffic Managemen	Working at Height	Hazardous Substances
Site Security	Fire Safety	Manual Handling	Site Set-up
Abrasive Wheels	Public Interface	Noise and Vibration	Welfare Arrangements

- 7) The Contractor shall adopt the following colour code scheme across all NMRL Sites to ensure efficient recognition of relevant personnel.

Safety Helmet Colour with Logo*	Designation
White	NMRL Staff and Engineer
Violet	Contractor's Engineers & Supervisors

Safety Helmet Colour with Logo*	Designation
Blue	Sub-Contractor's Engineers & Supervisors
Red	All Electricians
Green	Safety personnel
Orange	Security Guards & Traffic Marshals
Yellow	General Workforce
White (With VISITOR Sticker)	Visitors

Note: LOGO*

- (i) Logo shall have its outer dimension 2"×2" and shall be conspicuous
- (ii) Logo shall be either painted or affixed
- (iii) No words shall come either on Top / Bottom of Logo

Logo of the corresponding main contracting company for their employees and sub-contracting company for their employees shall only be used.

4.4.7 Emergency preparedness and response

4.4.7.1 Emergency Response Plan

- 1) The Contractor shall prepare a project specific Emergency Plan and submit to the Engineer for notice of no objection. The Emergency Plan shall be submitted within 4 weeks of contract Commencement.
- 2) The plan must identify the potential for emergencies and the provisions for responding to such emergencies, particular to their environment and location. The Emergency planning arrangements shall be assessed as per the provisions in OHS&E Volume 2 for suitability.
- 3) The Contractor shall ensure that all persons including Sub-contractors on site are aware of the emergency procedure to follow in the event of an emergency. Awareness training shall commence at induction and thereafter through refresher training such as toolbox talks and monthly emergency drills. Records of refresher training and emergency drills shall be maintained.
- 4) Site signage shall be erected and detail the emergency process to follow and include emergency telephone numbers, fire, ambulance, police, nearest hospital etc.
- 5) Arrangements shall be made by the Contractor for casualty evacuation and emergency medical treatment. The Contractor shall enter into an agreement with a hospital to provide ambulance services. Alternatively the Contractor shall provide a fully equipped ambulance on-site that shall be manned by a paramedic. This provision shall be subject to the Engineers audit.

4.5 Checking

4.5.1 Performance measurement and monitoring

- 4.5.1.1 The Contractor shall submit a Monthly OHS&E Progress Report no later than 7th of each month to the Engineer. The Report shall contain the minimum

information specified within OHS&E Volume 2 (refer Part 4, Section XIV). The report shall contain text, tables and colour photographs.

4.5.1.2 Site Inspection

- 1) Independent of the plant and equipment inspection, testing and maintenance regimes that shall be stated within the Contractor's Plant and Equipment Procedures, the Contractor shall carry out site monitoring exercises on a daily and weekly basis.
- 2) The Contractor shall ensure that all monitoring equipment is calibrated as per the manufactures requirements. The Engineer shall be provided with test certificates for such equipment
- 3) Site Engineers shall be required to participate in daily internal OHS&E inspections to facilitate prompt communication and rectification of minor deviations. Records of such inspections and rectification needs shall be maintained at site level and made available for review by the Engineer other interested parties.
- 4) Formal site inspection reports shall be produced on a weekly basis by the Contractor's OHS&E personnel for each site and submitted to the Project Director and copied to the Contractor's General Manager.
- 5) The Contractor may choose inspection format of his/her choice, however format shall contain the minimum information as provided within OHS&E Volume 2 (Reference Document, Section XIV) regarding weekly inspection form.
- 6) The Contractor's OHS&E Personnel shall be accompanied during a formal site inspection by the Site Manager responsible for the particular site. The resulting inspection report shall be signed by both the Site Manager and the OHS&E officer.
- 7) The Engineer shall formally inspect and report the Contractor's site conditions against the compliance criteria set within the Contractor's operational procedures and the Engineer's requirements on a weekly basis. These inspections shall include batching plant and associated yards.
- 8) The Contractor shall undertake specific inspections at the Engineer's request where concerns have been raised regarding the suitability of control measures and or plant or equipment condition. Such inspections shall be carried out with immediate effect. Reference Document, Section XIV, Clause 24.1.1 regarding the maximum permissible age of the plants and equipment

4.5.2 Evaluation of compliance

- 4.5.2.1 The information submitted by the Contractor within the OHS&E Monthly Progress Report together with the Engineer's Reports shall be evaluated against the Employer's compliance requirements and OHS&E objectives.
- 4.5.2.2 Inspection reports shall be evaluated against the Legal Requirements given in section 4.3.2 to which the Contractor is bound to comply.
- 4.5.2.3 The Contractor's OHS&E Committee shall formally evaluate reports and results of accidents and or injury on a monthly basis. The results of this evaluation such as identified changes to safe systems of working' shall be included with the Committee minutes

4.5.2.4 The Engineer shall evaluate 'Accident Injury Rates' and 'Frequency Rates' per individual Contractor and as a project to determine performance against the international rates. The international rates used to benchmark performance shall be promulgated to all Contractor's and other interested parties.

4.5.2.5 A Project Monthly Progress Report shall be produced by the Engineer. Evaluation results shall be included within the relevant sections for Health Safety & the Environment.

4.5.2.6 The Contractor's External OHS&E Audits (Refer section 4.5.5. below) shall be evaluated by the Engineer against the internal Standards BS EN 18001:2007 AND ISO 14001:2004.

4.5.3 Incident investigation, nonconformity, corrective action and preventive action

4.5.3.1 Incident investigation

- 1) The Contractor shall undertake accident investigation for all fatal accidents, major injuries and dangerous occurrences as defined within the OHS&E VOL 2 (Reference Document, Section XIV).
- 2) In the event of a fatality, major injury or dangerous occurrence, the Contractor shall not disturb the accident scene or remove equipment beyond that required to make the area safe and/or for the treatment and/or removal of casualty(s) to hospital.
- 3) Should the Engineer find an accident scene disturbed beyond that reasonably expected with making an area safe, this shall be subject to thorough investigation by the Engineer
- 4) The Engineer shall be informed immediately of all fatalities, major injuries or dangerous occurrences. Any delay in reporting to the Engineer may be subject to disciplinary action.
- 5) The Contractor is responsible to report accidents, incidents and dangerous occurrences to the relevant governing bodies as per their statutory obligations. The Contractor shall maintain responsibility for ensuring Sub-contractor's under their direct control also comply with this requirement.
- 6) A preliminary accident notification report shall be issued to the Engineer for all fatal and major injuries and or dangerous occurrences within 12 hours as per OHS&E Volume 2 (Reference Document, Section XIV). This shall be followed by the detailed accident report as per OHS&E Volume 2 within 48 hours of the investigation completion.
- 7) Near misses and minor accidents should also be investigated by the Contractor as soon as possible as they are signals that there are inadequacies in the safety management In case of fatal accidents, major injuries or dangerous occurrences the Engineer shall conduct an independent investigation. The Contractor and his staff shall extend the necessary co-operation.

4.5.3.2 Nonconformity, corrective action and preventive action

- 1) The Contractor shall conform to their internal procedures regarding nonconformity, corrective action and preventive action. The Contractor shall be audited by the Engineer for compliance with internal procedures.
- 2) Major and Minor non-conformances shall be raised by the Engineer as per the Employer's Quality Management requirements and the OHS&E Audit

criteria as defined within OHS&E Volume 2.

- 3) Open non-conformances shall be reflected in the Contractor's Monthly Audit Report and are subject to verification by the (Reference Document, Section XIV) as detailed in OHS&E Volume 2. Failure to successfully take corrective action and close out non- conformances will impact negatively on the Contractor's total quarterly audit score (Refer section 4.5.5 below).
- 4) Where non-conformances have been raised by an External Auditor against the BS EN 18001:2007 or ISO 14001 Standard, the Contractor shall produce and submit for review within 2 weeks, an action plan of how and within what timescale shall the non- conformance(s) be closed-out.
- 5) Where the corrective action and preventive action identifies new or changed hazards or the need for new or changed controls, the proposed actions shall be taken through the risk assessment process. The associated method statement and risk assessment shall be amended and re-submitted to the Engineer for notice of no objection.
- 6) A change in work methodology shall be communicated to the workforce. Evidence of such communications shall be made available for inspection by the Engineer. The Engineer shall also make random enquiries at site level to establish workforce awareness.

4.5.4 Control of records

- 4.5.4.1 The Contractor shall maintain all OHS&E records in accordance with the Contractors ISO 9001 Quality Management System.
- 4.5.4.2 Records shall be made available to the Engineer upon request for the purpose of incident investigation and management review.

4.5.5 Audit

4.5.5.1 Monthly Audit Report (MAR)

- 1) The Contractor shall undertake an internal monthly audit using the process and audit report form (MAR) as prescribed within OHS&E Volume 2.
- 2) The Contractor shall submit the completed audit report no later than the 7th of each month within the Contractor's monthly OHS&E Report. Failure to submit the monthly audit report within the stipulated timescale shall result in the Engineer awarding a 'Zero' scores for the month.
The audit scores awarded internally by the Contractor shall be subject to review and verification by the Engineer. The Engineer shall substantiate the awarded scores through making comparison with the results of a physical site inspection against the model audit scores criteria as provided within OHS&E Volume 2
- 3) The Engineer shall formally verify that the Contractor's self awarded scores comply with the audit scoring system and scoring criteria as defined within OHS&E Volume 2. Where discrepancy exists the Engineer shall provide supporting evidence (Photographic) and instruct the Contractor to amend the initial awarded score. Following adjustment, the monthly audit report shall be re-submitted to the Engineer within 3 days.
- 4) The Contractor shall be required to achieve a minimum 65% overall audit score on a monthly basis.
- 5) Monthly audit scores shall be totalled over a 3 month (3 audit results)

period. Where the average score for three (3) months of audits is below 65%, then the OHS&E lump sum item in the preliminaries section of Section on Pricing, Part 1 pricing shall be withheld.

- 6) If non-payment of the lump sum item in preliminaries occurs as a result of failing to achieve the required 65% over a single quarterly reporting period, the Engineer may reinstate the lump sum item at his discretion should the Contractor achieve above 65% for the following six (6) consecutive monthly OHS&E audits equating to two (2) quarterly reporting periods. This repayment of the lump sum item shall not occur if the quarterly aggregate is less than 50%.
- 7) In the event the Contractor fails to achieve a minimum of 65% on a monthly audit, an action plan shall be submitted together with the audit results detailing the actions that shall be taken within timescales.
- 8) Monthly audits shall be conducted prior to the sitting of the Contractor's Safety Committee and shall form part of the agenda.
- 9) A copy of each Audit Report will be sent to Employer and to all subcontractors, with whom it will then be discussed in detail at the Monthly SHE Committee Meeting in order to ensure that any corrective actions are agreed upon.

4.5.5.2 External OHS&E Audit

- 1) The Contractor is required to conduct external audits as per the BS EN 18001:2007 & ISO 14001:2004 international standards on a quarterly basis throughout the Contract period or until the Contractor achieves accreditation to the standard whereby monitoring timescales shall be instructed by the ISO accrediting body.
- 2) External audit and follow up audit reports shall be submitted to the Engineer for review within 7 days of audit completion.
- 3) Should the Contractor fail to undertake external audits within the 3 month period the Engineer shall appoint an ISO accredited 3rd party agency to conduct the audit at the Contractor's cost.
- 4) Where 'Major' non-conformances with international standards are identified, a follow-up external audit shall be carried out within 28 days for closing out of the non-conformance(s). Follow-up audits shall continue on a 28 day rotation until such time as Major non-conformances are closed to the satisfaction of the 3rd Party ISO accredited auditor.

4.6 Management review

- 4.6.1 Management Reviews shall be undertaken annually by the Engineer in compliance with ISO 9001:2008.
- 4.6.2 The Management Review Report shall make recommendations for improvement.
- 4.6.2.1 The Contractor shall carry out a formal Management Review on an annual basis as a minimum. The Management Review may form part of the review under the organisations Quality Management System.

The Contractor shall submit Management Review Report to the Engineer within 7 days after meeting completion together with the organisations new objectives

5. Penalty and Awards

5.1 Charges To Be Recovered From Contractor For Unsafe Act Or Condition

- 1) MAHA-METRO intends to build an image of safety conscious organisation. Any reportable accident (fatality / injury) results in loss of life and/or property damage. These accidents not only result in loss of life but also damage the reputation of MAHA-METRO. Most of the accidents are avoidable and caused preliminarily due to Contractors' negligence. Hence MAHA-METRO shall recover the cost of damages from the Contractors for every reportable incident (fatality / injury).
- 2) In addition every MAHA-METRO work site is exposed to public scrutiny as the work is executed just on the right-of-way. Any unsafe act / unsafe condition observed by public further damage MAHA-METRO's reputation. In view of this, MAHA-METRO has decided to establish safety-enforcing organisation. The cost of establishing such organisation is to be recovered from Contractors for all observed safety violations at sites.
- 3) The following table indicates the Safety, Health and Environment violation (unsafe act / unsafe condition) and charges to be recovered from contractors.

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
1	SHE Policy & Plan	i) SHE policy. a) non-compliance of clause 6.1 Volume 2	L1→L2	L1- Rs 5,000 per single violation, compounded to a maximum of Rs 25,000 at any single instance. L2- Rs 10000 per single violation, compounded to a maximum of Rs 50,000 at any single instance.
		ii) SHE plan (Clause 6.2, 6.4 & 6.7 – Volume 2)	L1→L2	L1- Rs 100000 per single violation, compounded to a maximum of Rs 200000 at any single instance. L2- Rs 200000 per single violation, compounded to a maximum of Rs 400000 at any single instance.
		a) Not as per Employers' content and coverage b) Delay in submission c) Not updated as per Employer's instruction d) Copies not provided to all required supervisors/engineers		

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
2	SHE Organisation	Not complying to the minimum manpower requirements as mentioned in Table 2 – OSH&E Personnel Qualifications & Experience (Clause 4.4.1.2 – Appendix 20)	L1→L2	L1- Rs100000 per month for first month and Rs 200000 for subsequent months. L2- Rs250000 per month for first month and Rs 500000 for subsequent months.
		Not filling up the vacancies created due to SHE personnel leaving the Contractor within 14 days. (Clause 4.4.2.3 – Appendix 20)		L1- Rs 50000 for first month and Rs 100000 for subsequent months. L2- Rs 150000 for first month and Rs 300000 for subsequent months.
		SHE organisation not provided with required Audiovisual and other equipment's as per General Instruction. MAHA-METRO /SHE/GI/006 (Clause 4.4.2.3 (item 4) – Appendix 20)		L1- Rs 50000 for first violation and Rs 100000 for subsequent violations. L2- Rs 150000 for first violation and Rs 300000 for subsequent violations.
		Employing through outsourcing agencies and SHE personal are not in the payroll of the main (Clause 4.4.2.3 (item 2) – Appendix 20)		
		Disobedience / Improper conduct of any SHE personnel. (Clause 4.4.1.6 – Appendix 20)		
		Reporting of SHE Personnel (Clause 4.4.2.3 (item 3) – Appendix 20)		
3	SHE committee	Failed to formulate or conduct SHE Committee meeting for any month (Clause 9.2.4 – Volume 2)	L1→L2	L1- Rs 100000 for the first violation and Rs 500000 for the subsequent violations. L2- Rs 200000 for the first violation and Rs 1000000 for the subsequent violations.

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
		Contractor and Sub-contractor representatives not attending SHE Committee meetings (Clause 9.2.6 – Volume 2)		L1- Rs 5000 to the contractor of the member who had not attended the meeting for first violation and Rs 25000 for subsequent violations. L2- Rs 10000 to the contractor of the member who had not attended the meeting for first violation and Rs 50000 for subsequent violations.
		Failed to conduct Site inspection before conducting SHE Committee meeting (Clause 9.2.2 (I) – Volume 2)		L1-Rs 25000 for first violation and Rs 50000 for subsequent violations. L2-Rs 50000 for first violation and Rs 100000 for subsequent violations.
		Failed to send SHE Committee Meeting minutes or Agenda to Employer in time (Clause 9.2.4 & 9.2.5 – Volume 2)		
		Non-adherence of Clause 9.2.5 – Volume 2		
		Non-adherence of Clause 7.9 – Volume 2		
4	ID card	Non-adherence of Clause 7.3.1, 7.3.2 & 7.3.3 – Volume 2	L1→L2	L1- Rs 100000 for first violation and Rs 200000 for subsequent violations. L2- Rs 250000 for first violation and Rs 500000 for subsequent violations.
5	SHE Training	Not complying to the requirements as mentioned in conditions of contract on SHE and project SHE manual with regard to:		
		a) Induction training not given (Clause 7.3.1 – Volume 2)	L1→L2	L1- Rs 50000 for first violation on and Rs 100000 for subsequent violations. L2- Rs 150000 for first violation on and

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
		b) Supervisor / engineer / manager training not conducted as per Clause 6.1.2 (b) – Volume 2 c) Refresher training as per Clause 6.1.3 & 6.1.9 – Volume 2 not conducted d) Tool-box talk not conducted as per Clause 6.1.6 – Volume 2 e) Skill development training not conducted as Clause 6.1.8 – Volume 2 f) Daily Safety Oath not conducted as per Clause 6.1.1 – Volume 2 g) Top management behavior based SHE training conducted Clause 6.1.4 – Volume 2 h) underground construction training not given		Rs 300000 for subsequent violations.
6	SHE Inspection	i) Not complying to the requirements as mentioned in conditions of contract on SHE and project SHE manual as per Clause 8 – Volume 2 ii) Non compliance of clause 8.1.7 – Volume 2	L1→L2	L1- Rs 50000 for first violation on and Rs 100000 for subsequent violations. L2- Rs 150000 for first violation on and Rs 300000 for subsequent violations.
7	SHE audit	Internal Audit: MARS i) Not conducted as per SHE Plan (Clause 4.5.5.1 (c) & (i) – Appendix 20) ii) Report not sent to Employer (Clause 4.5.5.1 (j) – Appendix 20)	L1→L2	L1- Rs 50000 for first violation on and Rs 100000 for subsequent violations. L2- Rs 150000 for first violation on and Rs 300000 for subsequent violations.

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
		iii) Action not taken for any month (Clause 4.5.5.1 (d) – Appendix 20)		
		External Audit		
		Not conducted as per SHE Plan (Clause 4.5.5.2 (a) – Appendix 20)		L1-Rs 100000 for first violation and Rs 200000 for subsequent violations. L2-Rs 250000 for first violation and Rs 500000 for subsequent violations.
		Report not sent to Employer (4.5.5.1 (b) & 4.5.5.2 (b) – Appendix 20)		
		Action not taken for any quarter (Clause 8.2 – Volume 2)		
8	SHE Communication	Important days to be observed for SHE awareness as furnished by Employer not observed (Clause 15.1.3 – Volume 2)	L1→L2	L1- Rs 10000 for first violation and Rs 50000 for subsequent violations. L2- Rs 20000 for first violation and Rs 100000 for subsequent violations.
		Posters as furnished by Employer not printed and displayed (Clause 15.1.3 – Volume 2)		L1- 2,00,000 per contract L2- 4,00,000 per contract
9	SHE Submittals	Non compliance of Clause 9.2.2 – Volume 2	L1→L2	L1- Rs 50000 for first violation on and Rs 100000 for subsequent violations. L2- Rs 150000 for first violation on and Rs 300000 for subsequent violations.
		Non compliance of Clause 5.14 & 9.3		L1-Rs 100000 for first violation and Rs 200000 for subsequent violations. L2-Rs 250000 for first violation and Rs 500000 for subsequent

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
				violations.
10	Injury and Incidence reporting	Fatal accidents	L3	L3- Rs 500000 penalty and enforcement of embargo for first fatality ,and Rs 1000,000 penalty and enforcement of embargo for every subsequent fatality.
		Injury accident	L2→L3	L2- Rs 100000 for first grievously injured person and Rs 200000 for every subsequent grievously injured person (Grievous Injury as defined by Workmen Compensation Act). L3- Rs 250000 for first grievously injured person and Rs 500000 for every subsequent grievously injured person
		Abnormal delay in reporting accidents or wilful suppression of information about any accidents / dangerous occurrence as per Clause 5.3.10 – Volume 2	L2→L3	L2-Rs 100000 for first violation and Rs 200000 for subsequent violations. L3-Rs 250000 for first violation and Rs 500000 for subsequent violations.
11	Emergency preparedness Plan	Non-compliance of the Clause 14 – Volume 2	L2→L3	L2- Rs 100000 for non-compliance of any of the clauses . L3- Rs 200000 for non-compliance of any of the clauses .
12	Housekeeping	Clause 10 – Volume 3 : <ul style="list-style-type: none"> Housekeeping maintenance register not properly maintained up to date Surrounding areas of drinking water tanks / taps not hygienically cleaned / maintained Office, stores, toilet / urinals not properly cleaned and maintained. Required dustbins at appropriate places not 	L1→L2	L1- Rs 10000 per single violation Compounded to a maximum of Rs 100000 at any single instance. L2- Rs 20000 per single violation Compounded to a maximum of Rs 200000 at any single instance

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
		provided / not cleaned.		
		<p>Clause 10 – Volume 3</p> <ul style="list-style-type: none"> • Stairways, gangways, passageways blocked. • Lumber with protruding nails left as such • Openings unprotected • Excavated earth not removed within a reasonable time. • Truck carrying excavated earth not covered / tyres not cleaned. • Vehicles / equipment's parked / placed on roads obstructing free flow of traffic • Unused surplus cables / steel scraps lying scattered • Wooden scraps, empty wooden cable drums lying scattered • Water stagnation leading to mosquito breeding 		
13	Working at Height / Ladders and Scaffolds	<p>Clause 17.4 – Volume 2 :</p> <ul style="list-style-type: none"> • Not using or anchoring Safety Belt • Not using Safety Net • Absence of life line or anchorage point to anchor safety belt (clause 17 – Volume 2) 	L2→L3	<p>L1-Rs 10000 per single violation Compounded to a maximum of Rs 100000 at any single instance.</p> <p>L2-Rs 20000 per single violation Compounded to a maximum of Rs 200000 at any single instance.</p> <p>L3-Rs 30000 per single violation Compounded to a maximum</p>

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
		Non-compliance of Clause 17.2 – Volume 2		of Rs 300000 at any single instance.
		Clause 17.3 – Volume 2 : <ul style="list-style-type: none">Improper usage (less than 1m extension above landing point, not maintaining 1:4 ratio)Aluminium ladders without base rubber bushUsage of broken / weak laddersUsage of re-bar welded ladders	L1→L2	
		Clause 17.3 – Volume 2 <ul style="list-style-type: none">Painting of laddersUsing Bamboo ladders	L1→L2	
		Improper guardrail, toe board, barriers and other means of collective protection – Clause 17.1.3 – Volume 2	L2→L3	
		Improper working platform Clause 17.2 – Volume 2		
		Working at unprotected fragile surface (Clause 17 – Volume 2)		
14	Lifting appliances and gear	Clause 19 – Volume 2 : <ul style="list-style-type: none">Non-compliance of clause 19Non availability of fitness certificateDocuments not displayed on the machine or not available with the operatorMaximum Safe Working Load not written on	L2→L3	L2-Rs 50000 per single violation Compounded to a maximum of Rs 500000 at any single instance. L3-Rs 100000 per single violation Compounded to a maximum of Rs 1000000 at any single instance.

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
		<p>the machine</p> <ul style="list-style-type: none"> Automatic safe load indicator not provided or not in working condition Age of the operator less than 21 years or without any licence and non-compliance of other item Non-compliance of any of the items mentioned regarding rigging requirements Failure to submit method statement in case of all critical lifting Person riding on crane. 		
		Creating more noise and smoke (Clause 17 – Volume 2)		
		Absence of portable fire extinguisher in driver cabin (Clause 31.5)		
		Fail to guard hoist platform (Clause 24.0)		
		No fencing of hoist rope movement area (Clause 24.0)		
		Hoist platform not in the horizontal position (Clause 19 – Volume 2)		
15	Site Electrical	Non-compliance of Clause 4.4.1.2 - Appendix 20	L2→L3	L2-Rs 10000 per single violation Compounded to a maximum of Rs 100000 at any single instance.
		Non-compliance of Clause 21.1.3 – Volume 3		

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
	safety	Non-compliance of Clause 21.3, 21.4 and 21.1.5 – Volume 2 Non-compliance of Clause 26.10 and 26.13 Inserting of wires directly into the socket Improper grounding for the electrical appliances Clause 21.3 – volume 2) Electrical cables running on the ground (clause 21.4 – Volume 2) Non-compliance Clause 26.3 – Volume 2		L3-Rs 20000 per single violation Compounded to a maximum of Rs 200000 at any single instance
16	Gas Cutting	Clause 21.1, 22.2 and 22.3 - Volume 3 <ul style="list-style-type: none"> • Wrong colour coding of cylinder. • Cylinders not stored in upright position • Flash back arrester, non-return valve and regulator not present or not in working condition. • Fail to put cylinders in a cylinder trolley. • Damaged hose and fail to use hose clamps • Using domestic LPG cylinders • Fail to store cylinder 6.6m away from fire prone materials • Fire extinguisher not placed in the vicinity during operation 	L2→L3	L2-Rs 10000 per single violation Compounded to a maximum of Rs 50000 at any single instance. L3-Rs 20000 per single violation Compounded to a maximum of Rs 100000 at any single instance.

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
17	Welding	Clause 21.1, 22.2 and 22.3 - Volume 3 <ul style="list-style-type: none"> Voltmeter and Ammeter not working Non-availability of separate switch in the transformer Improper grounding and return path. Damaged and bare openings in the welding cable. Damaged holder Fire extinguisher not placed in the vicinity during operation 	L2→L3	L2-Rs 10000 per first violation and Rs 50000 for subsequent violations. L3-Rs 100000 per first violation and Rs 500000 for subsequent violations.
18	Compressed gases	Storage of compressed gases clause 23.1.4, 23.1.6 and 23.1.7 – Volume 2	L2→L3	L2-Rs 10000 per first violation and Rs 50000 for subsequent violations. L3-Rs 100000 per first violation and Rs 500000 for subsequent violations.
19	Blasting	Authorization and Risk assessment of blasting	L2→L3	L2-Rs 10000 per first violation and Rs 50000 for subsequent violations. L3-Rs 100000 per first violation and Rs 500000 for subsequent violations.
20	Fire precaution	Smoking and open flames in fire prone area (Clause 36.1.5 – Volume 2)	L2→L3	L2-Rs 5000 per single violation Compounded to a maximum of Rs 25000 at any single instance. L3-Rs 10000 per single violation Compounded to a maximum of Rs 500000 at any single instance.
		Absence of fire extinguishers (Clause 36.2.1 – Volume 2)		
		Fire extinguishers not refilled once in a year. (Clause 36.2.2 – Volume 2)		

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
		Fire extinguisher placed in a not easily accessible location		
21	Excavation, Tunnelling and confined space	Non-compliance of Clause 26	L2→L3	L2-Rs 10000 per single violation Compounded to a maximum of Rs 50000 at any single instance. L3-Rs 20000 per single violation Compounded to a maximum of Rs 100000 at any single instance.
		Not following the entry procedure for work in confined spaces Clause 20.3 – Volume 2		L2-Rs 10000 per first violation and Rs 50000 for subsequent violations. L3-Rs 100000 per first violation and Rs 500000 for subsequent violations.
22	Work permit system	Non-compliance of Clause 13.3 – Volume 2	L2→L3	L2- Rs 50000 per first violation and Rs 100000 for subsequent violations. L3- Rs 100000 per first violation and Rs 200000 for subsequent violations.
23	Traffic Management	Non-compliance of Clause 38.1 – Volume 2	L2→L3	L2-Rs 100000 per first violation and Rs 200000 for subsequent violations. L3-Rs 250000 per first violation and Rs 500000 for subsequent violations.
		Non-compliance of Clause 39.1 – Volume 2		
		Non-compliance of Clause 38.4		
		Non-compliance of Clause 38.5		
		Barricades (Clause 37.1 – Volume 2) <ul style="list-style-type: none"> Not Cleaned Not in alignment Not numbered 	L2	Rs 25000 per single violation Compounded to a maximum of Rs 100000 at any single instance

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
		<ul style="list-style-type: none"> Not painted Red lights /reflectors not working Damages not repaired Not secured properly Barricade inspector not employed Protruding parts / portions repaired Barricades maintaining register not properly maintained up to date 		
		Contractor Vehicles <ul style="list-style-type: none"> Over loading of vehicles Unfit drivers or operators Unlicensed vehicles Absence of traffic marshals Absence of reversing alarm Absence of fog light (at winter) vii) Power / hand brakes not in working condition. 	L2	Rs 25000 per single violation Compounded to a maximum of Rs 100000 at any single instance
		Splashing of slurry/muck on roads / non-cleaning of tyres of dumpers and transit mixers (Clause 10.8, item (i) & (k) – Volume 3) <ul style="list-style-type: none"> Mishandling of bentonite like splashing of bentonite outside specified width of barricading Non-cleaning of tyres of dumpers and transit mixers before leaving the site and thereby 	L2	a) Rs 100000 on first observation. b) Rs 200000 on second observation. c) Rs 300000 on third and subsequent observations

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
		creating a traffic safety hazard to road users.		
24	PPE (Personal Protective Equipment)	Not having PPE (Clause 34.1 – Volume 2)	L2→L3	L2-Rs 200 per single violation. L3-Rs 400 per single violation.
		Not wearing (or) using and kept it elsewhere (Clause 34.1 – Volume 2)	L2→L3	
		Using damaged one (Clause 34.2 – Volume 2)	L2→L3	
		Using wrong colour helmet or helmet without logo (Clause 4.4.6.4, item (g) – Appendix 20)	L1→L2	
		Not conforming to BIS standard (Clause 34.2 – Volume 2)	L2→L3	L2-Rs 10000 for first violation and Rs 50000 for subsequent violations . L3-Rs 100000 for first violation and Rs 200000 for subsequent violations .
		Non-compliance of Clause 34.1.4, 34.1.5 and 34.1.2 – Volume 2	L2→L3	L2-Rs 50000 for first violation and Rs 100000 for subsequent violations. L3-Rs 100000 for first violation and Rs 200000 for subsequent violations.
25	Occupational Health	Fail to conduct Medical examination to workers (Clause 35.2 – Volume 2)	L1→L2	L1-Rs 10000 per single violation Compounded to a maximum of Rs 100000 at any single instance. L2-Rs 20000 per single violation Compounded to a maximum of Rs 200000 at any single instance. L3-Rs 30000 per single violation Compounded to a maximum of Rs 300000 at any single instance.
		Absence of ambulance van & room (Clause 35.3 – Volume 2)		
		Workers not having ID card (Clause 7.3.2 – Volume 2)		

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
		Clause 35.1 and 35.4 – Volume 2 <ul style="list-style-type: none">Absence of first-aid person in work siteAbsence or inadequacy of first-aid box	L2→L3	
		Clause 35.1 and 35.4 – Volume 2 <ul style="list-style-type: none">Misuse of first-aid boxFirst-aid box not satisfy the minimum Indian	L1→L2	
		Smoking inside the construction site (Clause 35.3 (b) – Volume 2)		
		Drink and drive or work (Clause 35.5 (a) – Volume 2)		
		Fumigation / insecticides not sprayed to prevent Mosquito breeding (Clause 10.9 – Volume 3)		
		Non-compliance of Clause 16.4 – Volume 2		
26	Labour Welfare measures	Clause 16.5 – Volume 2: <ul style="list-style-type: none">Inadequate number of toiletsToilets not cleaned properlyToilet placed more than 500m from the work siteAbsence of water facilities for toilets and washing places	L1→L2	L1-Rs 10000 per single violation Compounded to a maximum of Rs 50000 at any single instance. L2-Rs 20000 per single violation Compounded to a maximum of Rs 100000 at any single instance.
Absence of drinking water (Clause 16.6 - Volume 2)				

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
		Excessive noise and vibration (Clause 17 – Volume 3)		
		Canteen not provided (Clause 46.2)		
		Food stuff not served on no loss no profit basis (Clause 16.8 (a)– Volume 2)		
		Clause 4.3.2.1 (b) – Appendix 20 : <ul style="list-style-type: none"> • Non adherence of Labour welfare provisions of BOCWA • Fail to register establishment and display the registration certificate at workplace • Absence of workers register and records • Absence of muster roll and wages register • Fail to display an abstract of BOCWA and BOCWR 		
27		Ventilation in Shaft	L2→L3	L2-Rs 10000 for first violation and Rs 50000 for subsequent violations . L3-Rs 100000 for first violation and Rs 200000 for subsequent violations .
26	Environmental Management	Tyre wash facility not provided (Section D2 – Employer’s Requirement)	L1→L2	L1-Rs 10000 per single violation Compounded to a maximum of Rs 50000 at any single instance.
		<ul style="list-style-type: none"> • Dust control measures at sites not practiced • Improper disposal of debris / residues • Spillage from vehicles not arrest 		L2-Rs 20000 per single violation Compounded to a maximum of Rs 100000 at any single instance.
		Air monitoring not practiced (Clause 15.4.3 –		

SN	Topic	Unsafe Act/Unsafe condition	Range of Levels	Deductible Amount
		Volume 2)		
		The values of air monitoring not within acceptable limits (Clause 15.4.3 – Volume 2)		
		Non compliance of Clause 9.4 & 9.4 (g)		

- 4) Without limiting to the unsafe acts and or conditions mentioned above in Clause 56.3 the Employer shall have the right to deduct charges for any other unsafe act and or condition depending upon the gravity of the situation on a case-to-case basis. The charges shall be in comparison with that of the similar offence indicated in Clause 56.3.
- 5) Non-conformities detected during inspections carried out by the Engineer are subject to a process adapted to the severity of the situation. Non-conformities are divided into 4 categories as follows:
 - A. Notification of observation of minor non-conformities. The non-conformity results in a notification to the on-site Contractor's representative, followed-up by a signed notification of observation prepared by the Engineer. The multiplication of notifications of observation at the Worksite, or absence of corrective actions by the Contractor, can result in the severity of the non-conformity being raised to that of level 1.
 - B. Level 1 non conformity: Non-conformities that do not represent a serious immediate risk for health and environment. The non-conformity is the subject of a report addressed to the Contractor and which shall be resolved within five (5) days. The Contractor addresses to the Engineer a report explaining how the non-conformity has been corrected. Further to an inspection and a favourable evaluation of effectiveness of the corrective action, the Engineer signs a close-out report for the non-conformity. In all cases where a non-conformity of level 1 is not resolved within one (1) month, the severity of the non-conformity is raised to level 2.
 - C. Level 2 non-conformities: applies to all non-conformities that have resulted in damage to health or the environment or which represent a high risk to health and the environment. The same procedure as for level 1 non-conformities is applied. Corrective action shall be taken by the Contractor within three (3) days. The Contractor addresses a report explaining the corrective actions implemented. All level 2 non-conformities which are not resolved within one (1) month, are raised to level 3.
 - D. Level 3 non-conformities: applies to all non-conformities that represent a risk with major consequences to health and the environment. The highest levels of the Contractor's and Engineer's hierarchies present in the Employer's country are informed immediately and the Contractor has twenty-four (24) hours to bring the situation under control. Clause 14.7 of the Particular Conditions of Contract (PC), a level 3 non-conformity results in the suspension of interim payments until the non-conformity has been resolved. If the situation requires, and in pursuance to Clause 8.8 of the PC, the Engineer can order the suspension of work until the resolution of the non-conformity.

2.0 STOPPAGE OF WORK

- 1) The Employer shall have the right to stop the work at his sole discretion, if in his opinion the work is being carried out in such a way that it may cause accidents and endanger the safety of the persons and / or property, and / or equipments. In such cases, the


Contractor shall be informed in writing about the nature of hazards and possible injury / accident.

- 2) The Contractor shall not proceed with the work until he has complied with each direction to the satisfaction of Employer.
- 3) The Contractor shall not be entitled for any damages / compensation for stoppage of work, due to safety reasons and the period of such stoppage of work shall not be taken as an extension of time for Completion of the Facilities and will not be the ground for waiver of levy of liquidated damages.

3.0 AWARDS

The following categories will be considered for awards as per the scheme in practice of Employer:

- (i) For every safe million man hour working without any reportable incidents
- (ii) Zero fatality contracts
- (iii) 100% adherence to voluntary reporting of all accidents throughout the currency of contract
- (iv) Safest project team of the year.
- (v) Best SHE team of the year.
- (vi) Safest Contractor of the year.

 <p>नागपुर मेट्रो NAGPUR METRO</p>	PUNE METRO RAIL CORPORATION LIMITED
<u>ANNEXURE NO.: 1</u>	

Memorandum of Understanding between MAHA-METRO and the Contractor for safe execution of contract work

This Memorandum of Understanding is made and executed by and between **Pune Metro Rail Corporation Limited (MAHA-METRO)**, a Company registered under the Companies Act 1956 and having its registered office at Koregaon Park or their authorized representative(s), hereinafter referred to as “**EMPLOYER**” (which expression shall wherever the context so requires or admits be deemed to mean and include its successors in business and assigns) of the one party

AND

M/s _____ having
its _____ registered _____ office _____ at
_____ hereinafter
referred to as the “**CONTRACTOR**” (which expression shall wherever the context so requires or admits be deemed to mean and include its successors in business and assigns) of the other party

WITNESSETH THAT

WHEREAS the EMPLOYER gives highest importance to the occupational safety, health and environment during execution of work, seeks cooperation from the CONTRACTOR in this endeavour.

Thus, this Memorandum of Understanding is for promoting the safety, health and environment aspects required to be followed at workplace/site and will be applicable to any site job to be done by the CONTRACTOR

AND

WHEREAS the CONTRACTOR has read all the terms and conditions of the EMPLOYER and whereas the CONTRACTOR has studied the following documents:

- (i) Tender Documents, including Notice Inviting Tender, General Conditions, Special Conditions;
- (ii) Conditions of Contract on Safety, Health and Environment and Project Safety, Health and Environment Manual;
- (iii) Building and Other Construction Workers (Regulations of Employment and Conditions of Service) Act 1996, Central Rules 1998 and subsequent MaharashtraBOCW Rules 2003, Building and Other Construction Workers Welfare Cess Act 1996 and Rules 1998 and notification [Central & State] Collection of cess.
- (iv) Indian Electricity Act 2003 and Rules 1956;
- (v) Corresponding International / Bureau of Indian Standard Codes.

Including the amendments to any of the above rules and any other rules & regulations or procedures, circulars, notices & advices laid down by the EMPLOYER from time to time.

Now it is hereby AGREED AND DECLARED by and between the EMPLOYER and the CONTRACTOR as follows:

- | | |
|--------------|---|
| Clause - I | The CONTRACTOR shall abide by the terms and conditions stipulated in Condition of Contract on Safety, Health & Environment and Project Safety, Health & Environment Manual. |
| Clause - II | The CONTRACTOR shall undertake full responsibility for safe execution of job at work place/site and safety of his personnel and adjoining road users during work. |
| Clause - III | Without giving any prior notice, the EMPLOYER shall from time to time be entitled to add/or amend any or all terms and conditions with a view to improving safety and occupational health of personnel and safety of work, with immediate effect and the same shall be binding on the CONTRACTOR. The Contractor agrees to implement all such amendments, which shall be laid down by the EMPLOYER. |
| Clause - IV | Besides following the guidelines, safety rules and regulations, safety codes given in various safety procedures/documents mentioned above, the CONTRACTOR shall also prepare detailed method statement which includes job safety analysis wherever there are complicated and hazardous/high risk working involved and get it approved from Employer before execution of work. |
| Clause - V | Any negligence or violation in implementing any of the provision of the conditions of contract on Safety, Health & Environment and MAHA-METRO project Safety, Health & Environment Manual shall be viewed seriously and the Contractor is liable to compensate the Employer for the loss of reputation. The cost of damage shall be fixed on case-to-case basis. |

In witness thereof the Parties hereto by representatives duly authorised have executed this Memorandum of Understanding on _____ day of _____ 20____.

Signed on

Signed on

For and on behalf of MAHA-METRO

For and on behalf of (Contractor)

Signature:

Signature:

Name:

Name:

Title:

Title:

Maha Metro



Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENTS

Section VI – Employer’s Requirements

Appendix 21 – Transit System Test and Commissioning

June 2018

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1. General

1.1 Document objectives – staged Revenue Service

The objective of this document is to define the scheduling of the tasks of test, commissioning and blank operation as well as the Contractor’s responsibilities.

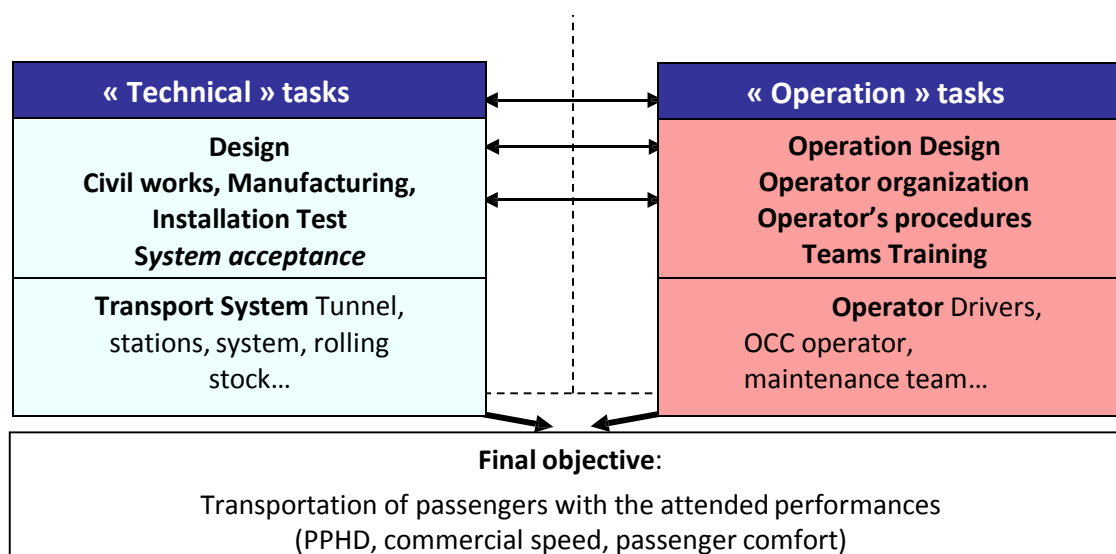
It describes the phases of the tests & commissioning process of the Transit System as a whole (Clause 2 below).

This document presents a typical sequence of tests to perform during overall tests and commissioning phase (Clause 4 below).

As Pune Metro will be put in revenue service in stages (see Clause 5), each stage will require the exact same below process (with the exception that part of service trial and blank operation for later stages will involve a bigger corridor length).

Important note: Several design requirements regarding the infrastructure (stations, tunnel...) and several safety criteria will be checked, demonstrated or validated through Working notes or Calculation notes. Although part of the overall system acceptance process is not dealt in this document, that is only limited to testing in a general and extended sense.

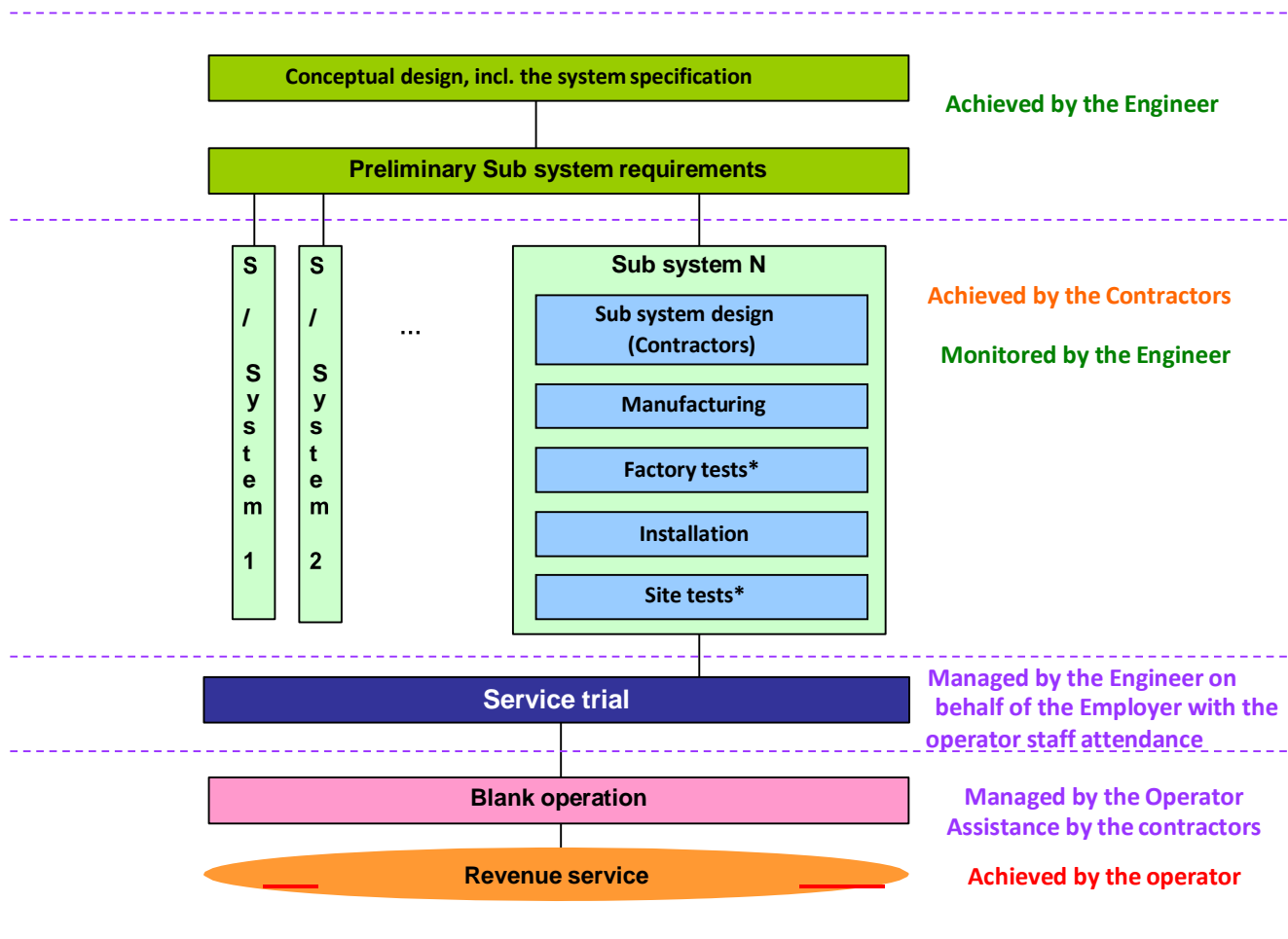
1.2 Pune Metro Project Process



The global project objective is the transportation of passengers with the attended performances. For that, it is necessary:

- to design and build all the necessary elements of the transport system,
- to check and validate the function units (test and commissioning)
- to put in place an operation team able to operate and maintain the metro system and ensure the forecasted transportation of passengers.

1.3 Pune Metro Project sequences and associated responsibilities



*Including liaising with Interfacing Contractors

2. Testing and Commissioning (T&C) process

The following chapters only provide a brief description in order to allow an easier understanding of the overall test and commissioning process.

For tests and commissioning detailed requirements refer to complete Contract Documents

2.1 Definitions

The tests and inspections are the final step in order to prove the quality control process of each project actor (Contractors, Employer, Engineer).

The tests objectives are to check that the design requirements (functional, performance, operational and technical) of the sub system and of the global transport system are achieved and respected.

Thus:

Each contractor shall prove that his sub-system is compliant with his contractual requirements and specifications, including interfacing with other subsystems.

The Employer (assisted by the Engineer) shall check that the global transport system is

compliant with the overall system and performances objectives and requirements.

The operator shall prove that his organisation fits in the need and that its procedures are efficient and adequate for a safe operation of the Transit system as a whole.

The test process will lead to the overall transport system acceptance and to its full commissioning.

Prior to the overall full system tests on site, inspections, tests and checks after manufacturing and assembly will be made either in the factory and / or on site upon delivery of sub-systems or components.

In the Test and Commissioning process, the term « System » means all the sub-systems working together.

A sub-system is a functional unit; it could be any type of subsystem, whether part of system contracts or part of civil contract.

A contractor can be in charge of one or several sub-systems.

2.2 Abbreviations / definition

The Employer = Maha Metro (Pune Metro)

T&C : Testing and Commissioning

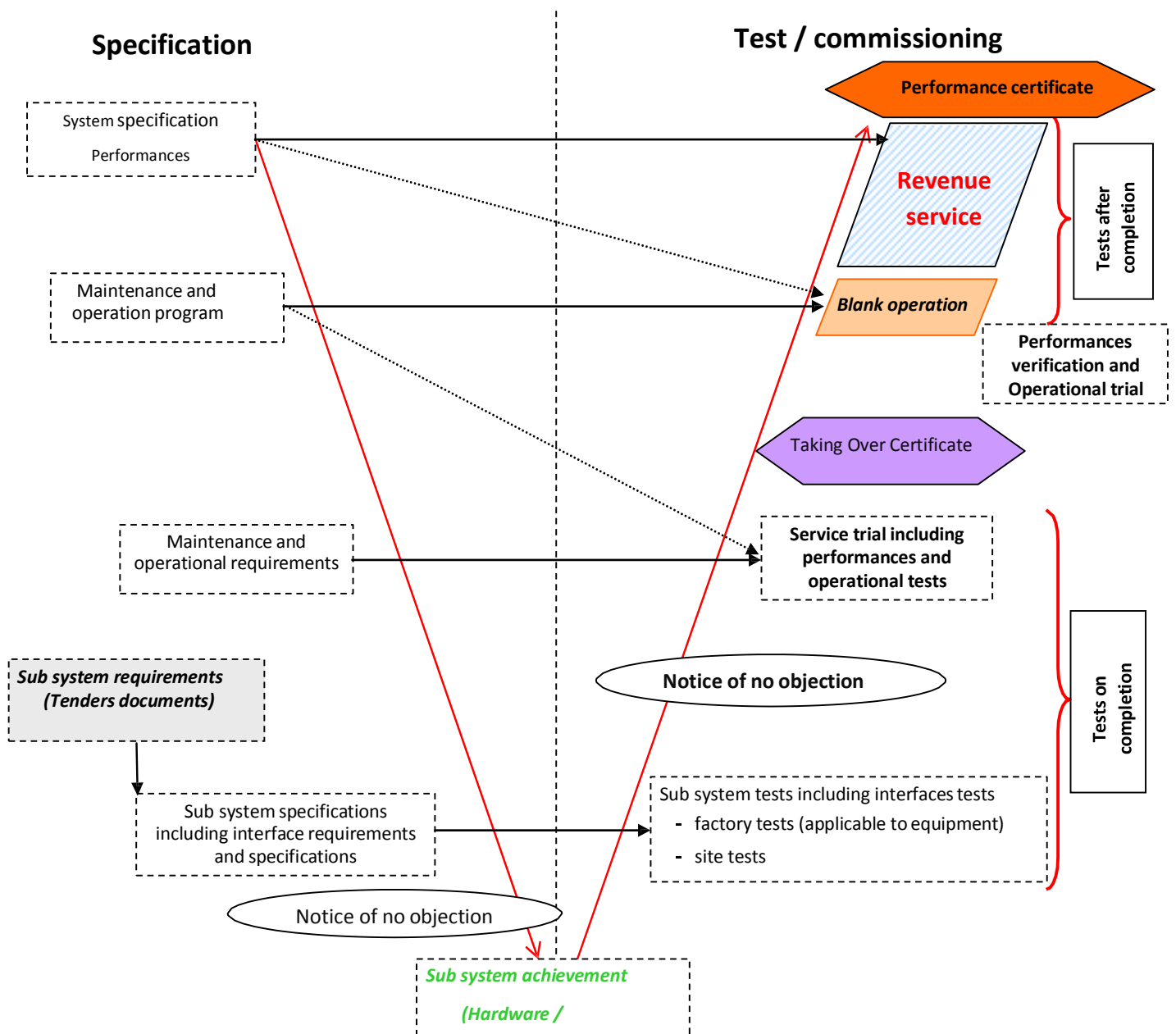
CRS : Commissioner for Railway Safety

Tests definition

	Test phases	Definition	Reference in this document	Contractual designation according to FIDIC
Sub – systems	Factory (or manufacturing) tests	tests achieved in factory	Clause 2.6.2	Tests on completion
	Installation tests		Clause 2.7.1	
	Partial and system acceptance tests		Clause 2.7.1	
	Integration testing and commissioning	interfaces tests	Clause 2.7.1	
	Service trial (or overall system tests)	global tests of the transport system	Clause 2.7.2	
	Issue of Taking Over certificate			Taking Over certificate
	Defects liability period	Warranty period	Clause 2.7.4.1	Start of Defect liability
	Blank operation	Operation without passenger (operator’s training)	Clause 2.8	Tests after completion

	Regular Verification	Service	Period to verify the performances	Clause 2.7.4.2	
					Issue of Performance Certificate

2.3 Specification – Validation process (V-cycle)



2.4 Test typology

The system validation consists on a pyramid-shaped process composed of a logical series of complementary test.

This process starts by tests and checks in factory (factory tests), continues by on-site tests and finished in operation phase (performances checking)

The list below gives the tests « typology » leading to the Transit System acceptance of the works:

1. Factory tests

Unit tests

- Type tests

- Routine tests

- Functional and operational tests

Integration tests

- Platform tests

- Test on test track (rolling stock...)

2. Site test

Sub system tests

- Installation tests

- Sub system tests static and dynamic (partial and system acceptance tests)

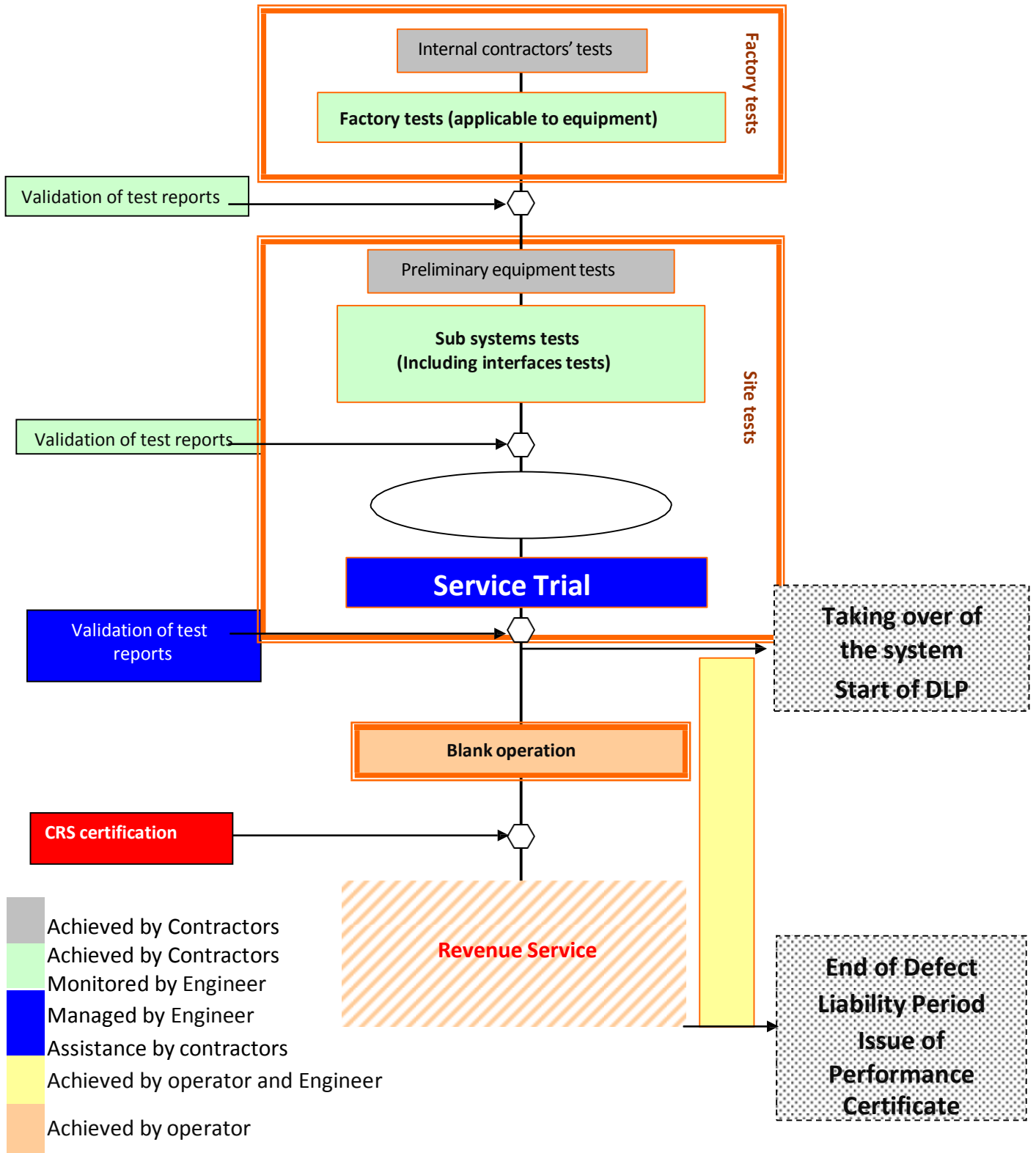
- Integration Testing and Commissioning (interfacing tests)

- Service trial (Overall system tests)

3. Blank operation

4. Regular Service verification (Performances checking)

2.5 Sequences of tests and validation steps



2.6 Tests at factory (applicable to equipment)

2.6.1 Internal contractor's tests

Before factory acceptance tests, the contractors shall test their sub-systems in order to guaranty the success of the factory acceptance tests.

Each contractor shall keep the results of such tests which can be audited by the Engineer at any time.

2.6.2 Factory tests

The objective of such tests is to check the compliance of the manufactured equipment with the technical and functional specifications and with the standards.

Test procedures

- The test procedures shall be written by the Contractor.
- These procedures are checked with notice of no objection by the Engineer

Tests execution

The factory tests shall be achieved by the Contractor and monitored by the Engineer.

At the end, an acceptance report shall be signed by the Contractor and notice of no objection will be issued by the Engineer, that will enable the equipment to be delivered to the site.

Factory tests consist of:

The type tests

The objectives are to check that the design of equipment is in compliance to technical and functional specifications (Contract Stipulations).

Routine tests

Tests of each train or equipment at the end of manufacture phase.

(Type tests applied to the first equipment, routine tests applied to the others)

Functional and operational tests

Test of functional and operational requirements

Factory integration tests

Some interfaces between subsystems need to be tested in factory (signalling and telecommunication, rolling stock and on-board signalling equipment...).

During this phase the different sub-systems will be connected together in order to test the functions achieved by the group of equipment.

This platform (group of equipment) will enable notably to test the compliance with operational criteria, ergonomic criteria of the man machine interfaces.

Those tests are essential as they shall prove the capacity of the subsystems to operate as an integrated system prior to be delivered to the site, and shall prevent each contractor to spend unnecessary time and resources on site to correct design/manufacturing based defects.

2.7 Tests on site

The objectives of such tests are to prove that:

The equipment was not damaged by the transportation, delivery process

The installation of the equipment is in compliance with specifications and drawings.

System and equipment operate properly in site environmental and operational conditions, according to the functional, technical and operational specifications.

The following issues shall be covered:

The installation

The sub-system tests (for each sub-system) including the interfaces tests.

The service trial (overall system tests).

2.7.1 Installation and site Sub-system tests

The objective of such test is to check the compliance of the subsystem with the technical and functional specifications and with the standards. Additionally the Contractor shall test the interfaces with others sub-systems in order to check the interface specifications, like forecasted in the Contract.

Test procedures

The test procedures shall be written by the contractor. These procedures are checked by the Engineer

Tests execution

The sub-system tests shall be achieved by the Contractor and reviewed without objection by Engineer

At the end an acceptance report shall be signed by the Contractor and the notice of no-objection issued by the Engineer

When all the sub-system tests will be performed successfully, the system test will be able to start

This test phase includes (see Employer’s Requirements, Section VI and other Contract Documents’')

- Installation tests
- Partial acceptance tests
- System acceptance tests
- Integration testing and commissioning

2.7.2 Service Trial (overall System tests)

2.7.2.1 Presentation

When all the sub-systems will be tested with success it will be possible to start the service trial tests.

The trial service objectives are to:

1. Prove the Overall System (all the sub-systems working together) operation is correct in normal mode, and degraded modes.

This part is the “cross functions tests” of the system

2. Prove that the system is fully operational: easy to operate for the operator staff,: OCC operators, driver, ... and easy to maintain.

This part is the “tests of ability to operate” of the system

3. Check also several Overall System performances such as commercial speed, minimal headway.... At this time , the first RAMS assessment will be done

This part is the “performance tests” of the System. To achieve these System tests the Contractors shall:

- Ensure the availability and readiness of each sub-system (but at this moment the sub-systems continue to be under the Contractors responsibility).
- Provide technical assistance to the Engineer in order to enable the Engineer to manage and complete the system tests.

Test procedures

The test procedures shall be agreed by the employer.

Tests execution

The service trial shall be achieved by the Engineer with the assistance of the contractors. The contractors shall foresee adequate staff to cover these services within the Contract obligations.

2.7.2.2 Cross functions

The main cross functions to be tested are the following;

These functions involve several sub-systems; they will be tested in normal and degraded mode.

N°	Cross function	Sub cross functions
1	Passengers movements between stations	<ul style="list-style-type: none"> - Train movement (automatic route control, train mission, traffic regulation...) - Boarding passengers - Train / passengers movement in case of emergency (tunnel evacuation...) - Etc.
2	Passenger movements in station	<ul style="list-style-type: none"> - Entry / Exit of the station - Access and exit of the platform - Movement in case of emergency evacuation - Etc.
3	Energy management	<ul style="list-style-type: none"> - Management of general power supply of the lines - Management of the traction current - Management of station power supply
4	Communication and passengers services	<ul style="list-style-type: none"> - Communication in the stations (video, public address...) - Communication in the trains (video, public address...) - Ticketing - Access to people with restricted mobility - Etc.

5	Operation management	<ul style="list-style-type: none"> - Management of OCC equipment - Management of station equipment - Service start up for the line (train preparation, line preparation, energy reconfiguration, first train of operation in the morning...) - End of service for the line (train stabling, station closing,...)
6	Maintenance management	<ul style="list-style-type: none"> - Management of maintenance tasks along the line - Management of maintenance tasks in the stations - Management of maintenance tasks in the depot - Management of maintenance tasks of trains (tow / push procedure for a train...) - Management of maintenance tasks of sub-stations

2.7.2.3 “Ability to Operate”

In order to prove this all the system functions (cross function) will be operated and it will be achieved by checking the system at the operator disposition whether it is easy to operate.

Agent in interface	Operation criteria	Tests
OCC operator	<p>Organization of the OCC Workstation ergonomics</p> <p>Man machine interface ergonomics:</p> <ul style="list-style-type: none"> o Information readability o Alarm display and priority o System control when dealing with alarms o Control panel : visibility and completeness of the information o Etc. <p>- In case of OCC failures</p> <ul style="list-style-type: none"> o Capability to continue to operate (how long to transfer to back up OCC/station controls) o How difficult is it to stop the traffic 	<p>Test of these criteria during normal and degraded mode checking the facility to and measuring some time to some operation</p> <p>Simulate an OCC failure and the according to the criteria</p>

Driver	<ul style="list-style-type: none"> - Driver desk ergonomics in all modes <ul style="list-style-type: none"> o In ATO mode o In ATP mode o In manual mode o Etc. - Easiness to shift from a mode to another and control of mode - Visibility of the way side signalisation - Quality of the communication with the OCC - Possibility for immediate onboard diagnostic of a 	
Staff in station	<ul style="list-style-type: none"> • Quality of the communication with the OCC , multiple call situation 	
Maintenance staff	<ul style="list-style-type: none"> - Quality of the computer Aided maintenance System etc. 	
Other	<p>In a general way, the system capability to deal with important incident will be tested</p> <ul style="list-style-type: none"> o Evacuation in line o Evacuation in station o Tow of a failed rake o Failure of OCC o Energy power failure o Etc. 	Simulate an incident in an operation configuration as close as possible from actual revenue service

2.7.2.4 Performance tests

- Speed performances:
 - o Commercial speed for normal service and partial services
 - o Commercial speed of a train set under load
 - o Run time of a manual driving train set
 - o Time of turn back for the terminus and for the partial terminus
 - o Etc.
- Headway:
 - o test of the minimal headway it may be not possible to perform this test because the number of the train will not be sufficient. However this test will be performed on partial section of the network considered as critical
- Energy :
 - o test under load : it may not be possible to do this test for all the line because the number of the trains set will not be sufficient. In this case this performance test will be done by electrical section.
 - o test of the traffic behaviour when suppressing one sub-station
- Remote control and remote indication:

Under load (all sub system and many trains in operation), measure the time of taking into account of remote controls and the time of transmission of remote indications

- RAM performances:

During the test phase all the failures and malfunction will be noted in order to have a first overview of the RAM performances, in particular the duration of some maintenance intervention will be measured.

2.7.3 Takeover of the system

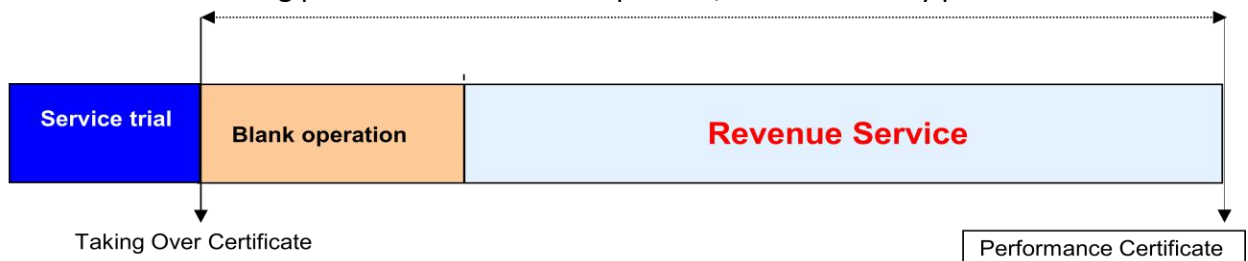
Only when all the sub system tests, all interfaces, integration tests and all the overall system tests are completed successfully will the service trial end. Then it will be possible to issue:

- The Taking Over Certificate (TOC) of each sub-system or contract, then the formal transfer of the system from the contractor to the Employer will be possible:
- The taking over from Contractors to the Employer (and from Employer to Operator). This will allow the Employer to run the blank operation and then to open the system for revenue Service. The release of the TOC will also allow the start of the Defect Liability Period.
- The Performance Certificate will be granted only at the end of Defect Liability Period (see below clause 2.7.4).

2.7.4 Performances checking – Tests after completion

2.7.4.1 Introduction

Performance checking period – Tests after completion / Defects liability period



This is only a principle sketch.

The duration of the Defects Liability Period (DLP) will be as precisely defined in each contract.

2.7.4.2 Tests after completion

During DLP, the operational performances will be observed in order to check if they are compliant to the Contract. These performances are depending on each contract, these are mainly:

- RAM performances
- Operation performances (whenever relevant)

During this period the global performances have to be met in order to comply with the Contract.

A group composed of the operator, the Engineer and the contractors insure the follow-up of these performances.

If necessary, special test or controls will be made to perform this follow-up. At the end of this period, a Performance Certificate is issued.

In case of failure of Tests after completion, see GCC clause 9.4.

2.7.5 Resolution of non-performance or poor performance level discovered during T&C.

While the construction is reaching its completion the correction of the as built equipment may become impossible besides it may be required to recheck the full

equipment interface when a non-performance is detected in order to appraise the effective impact of the poor performance as revealed through the T&C process.

The resolution is no different from the non-compliance process applicable to the Contract, except that the planning does not allow the redesign. Thus the Engineer may propose to the Employer to keep the project running on schedule provided that a safe level of operation can be achieved and propose a contingency plan in order to perform outstanding tasks and correct at a later stage through retrofit and retest of the defective equipment or item.

2.8 Blank operation

During blank operation the Operation and Maintenance staff will operate the line in an exact same way they will operate it during the revenue service except that there is no passengers. This period will allow the O&M staff to:

- Check that its organisation is fit for purpose and make necessary adjustments;
- Confirm that the system is able to operate and propose necessary adjustments,
- Train itself to implement O&M procedures under various circumstances including interfaces with external bodies (emergency services, fire brigade, public utilities services...)

2.9 Revenue service

The passenger transportation shall start after the end of the blank operation and after delivering of the CRS certificate.

This certificate relies on the safety case provided by each Contractor:

3. Sub - system (functional unit)

The sub-system included in each of the contract will be tested individually as a functional unit.

Contracts may include more than one sub system. For example the station contracts featuring the station construction include as well the provision for the building services to provide lighting, low voltage distribution and water related services etc..

Within each contract, each sub system function shall be tested individually (subsystem) to demonstrate the work completion and the compliance to the performance criteria. Within each contract each sub system function shall also be tested in relation to other interfacing subsystems (whether internal or external to each contract) to demonstrate the capacity of the said subsystem to operate in its environment (integrated tests and commissioning).

Main functional units within each contract are defined in Contract Documents .

4. Strategy of the tests

The T&C strategy for the Project will be based on progressive (i.e. increasing level of complexity and/or size) commissioning of testing package and/or area as mentioned and defined below.

4.1 Testing area

A Testing area/Commissioning area is defined as a basic geographical section of a system which constitutes an independent, consistent, functional and isolated assembly.

Examples of Testing area:

- All signalling equipment and material which are held in one signalling room or all trackside equipment which are monitored or controlled by one signalling room.

- All Catenary materials and equipment between two kilometric points.
- One rake unit
- Etc.

The division of a system or sub-system into testing area will allow using this splitting of the system for the Site acceptance test at subsystem level as soon as the installation is completed for the related equipment.

It is important that the testing areas are independent from each other and when added all together will constitute the whole system. Thus the test can run independently at first level then progressively progress through the integration to the final full System level. The splitting of the System / Subsystem into testing area will be proposed and agreed into the System and Subsystem Test and Commissioning Plans.

Testing area will be proposed by contractors for Engineer notice of no objection together with the T&C Plan for each contract.

4.2 Overall integration testing on site

The generic sequence of testing is described hereafter as to how the integration should progress among all different construction contracts. As a principle the integration is to be achieved progressively through the system level in order to reach the full system.

At the initial construction stage these test packages are to be divided through the type of work and through the contractual construction contracts (Civil, track, systems...) and the location along the line (equipment at one stop or from one place to another).

The principle that is to be followed for the integration at the T&C is to progress with the integration by testing the portion of line in between two stops and the facilities available at the stop. Thus gradually the full line will be integrated.

The table here below illustrates a typical indicative sequence of event (for information only) and shows the progression of the integration of all systems for a section of track. from one stop to the next.

Indicative Overall Integration Sequence

Test Sequence\ Sequence Order	Contract Impacted	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8	Stage 9	Stage 10
Stations (Station Building)											
Station Building	UG Civil										
Inspection and Compliance Check	UG Civil										
Utilities and Safety :											
Auxiliary Power and LV Distribution	UG Civil										
Access and Control System	UG Civil										
Security and Fencing	UG Civil										
Ambiant Air Renewal and HVAC	UG Civil										
Emergency Smoke Extraction	UG Civil										
Fire Fighting/Escape Route Provisions	UG Civil										
Fire Detection	UG Civil										
Earthing Bonding Stray Current (Lightning)	UG Civil										
Lighting	UG Civil										
Drainage and Water	UG Civil										
Passanger Services:											
Fare Collection (Gates + TVM)	AFC Equipment										
Public Information/ Commercial Desk	Singalling and Telecommunication										
Vertical Transport(Escalator & Lift for MIP)	UG Civil										
Public Address and Sound Distribution + PID	Singalling and Telecommunication										
Passanger Emergency Help Point	Singalling and Telecommunication										
Passanger Rest Area, Furniture, Signage	UG Civil										
PSD	Singalling and Telecommunication										
Local Integration :											
Local Supervision from Station Control Room	Singalling and Telecommunication										
Tunnel (between Two Adjacent Stations) :											
TrackBed/ Tunnel	Civil Work Contract										
Inspection and Compliance Check	UG Civil										
Sub-system Completion and Compliance :											
Track Inspection and Compliance	Track Works										
OHL Insulation Continuity and Compliance	Power supply System and OHE										
Power Supply (33kV networks...)	Power supply System and OHE										
Singalling and Telecom Cables	Singalling and Telecommunication										
Signal and Track Side Equipment	Singalling and Telecommunication										
Radio Cover and Functions	Singalling and Telecommunication										
Power on along Track Section 33kV and 25kV Traction Power	Power supply System and OHE										
Power on 25 kV Traction Power	Power supply System and OHE										
Overall Integration											
Centralised Supervision from Operation Control Center	Singalling and Telecommunication										
Transportation Test :											
Rolling Stock Inspection and Test (For Memory)	Rolling Stock										
Traction available	All Contractors										
Singalling available	All Contractors										
Trail Running in between two adjacent Station	All Contractors										

Once the line/part of it (section), is fully tested, overall system tests (service trial) will demonstrate the full section performances (trip time, headway, energy consumption...)

5. Commissioning stages (multi stages)

The Pune Metro construction may allow opening of line in stages.

So the tests & commissioning shall be achieved without any metro traffic perturbation and Safeguarding the operation safety of the section(s) already operational.

The contractors shall identify (according to the operator) all the critical points and take any measures to be compliant to these requirements; in particular many tests will have to be performed at night. The control command of these tests will be achieved in the test and commissioning room set up for this purpose.

6. Operator involvement during T&C

The operator will be involved progressively from the site acceptance test until the revenue service. The basic concept is that the operator staff is first involved as a witness during the site acceptance test of all equipment; this will help the effective training of the operator staff. During this stage the operator staff will only be present as a witness to the test carried out by the Contractor, all equipment are operated by the contractor staff.

During the integration test all work position of the operator will be handled by the operator to the extent decided by the Employer. The contractors will however supervise the operator staff. This means that rakes are driven by the operator drivers and that Control rooms are in effect operated by the operator, to the extent decided by the Employer. The contractor staff may attend and witness any of these tasks.

During the blank operation the operator staff will be working as for the revenue service. The contractor’s

Maha Metro



Tender Documents

**UGC-02: DESIGN AND CONSTRUCTION OF UNDERGROUND STATIONS AT
BUDHWAR PETH, MANDAI AND SWARGATE AND ASSOCIATED TUNNELS**

PART II – EMPLOYER’S REQUIREMENT

Section VI – Employers Requirement

Appendix 22 –BIM Execution Plan and Employers Information Requirements (5D BIM)

June 2018

MMRCL EIR (Employers Information Requirements)



Document Status	
Document Title	MMRCL Employers Information Requirements
Document Number	MMRCL-Pune Metro-EIR V1.0
Publication Date	20-April-2017
Issue Status	For MMRCL acceptance
Prepared by	
Reviewed by	
Approved by	

Revision Status			
Date	Revision Made	Revision by	Approved by

References			
No	Title	Version	Date
1	MMRCL EIR Standards, Methods and Procedures		20-April-2017
2	BS1192:2007+A2:2016 Collaborative production of architectural, engineering and construction information. Code of practice	2007+A2	2016
3	PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling		2013
4	MMRCL CAD Standard	V1.0	20-April-2017
5	MMRCL - Engineering Assurance File Naming Convention	V1.0	20-April-2017
6	MMRCL Design Review and Acceptance Procedure		
7	MMRCL Master Information Delivery Plan Template (MIDPT)	V1.0	20-April-2017
8	MMRCL Master Delivery List	V1.0	20-April-2017
9	MMRCL Master Production Delivery Table	V1.0	20-April-2017
10	MMRCL Level 2 BIM E2E Workflow Process	V1.0	20-April-2017
11	MMRCL Level 3 Drawing Process	V1.0	20-April-2017
12	MMRCL Level 3 Model Process	V1.0	20-April-2017

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1. PURPOSE

The purpose of this Employer Information Requirements (EIR) document (as a part of “**Business Requirement Document**”) is to provide specific details and instructions relating to Production Information and Handover Information [**Information Artefacts**] about the engineering solution of the MMRCL (Maha Metro Rail Corporation Ltd) asset and how these shall be captured, authored, managed and submitted to MMRCL or its agent [**the Employer**] by the Supplier / Detailed Design Consultant / Contractor [**the Supplier**].

The EIR sets out MMRCLs EIR standards, methods and procedures to be used for producing and managing Information Artefacts during each project phase, to make sure that the developed engineering solution meets project objectives and desired outcomes and benefits.

As such, it is incumbent on the Supplier to explain:

Pre-contract (if applicable):

As part of the Supplier tender submission and scope of services, and specifically within the pre-contract BEP (BIM Execution Plan):

- how the Supplier intends complying with the MMRCL Design, Review and Acceptance procedure
- how the Supplier intends complying with MMRCL EIR SMP (Standards, Methods and Procedures)
- how the Supplier will help MMRCL achieve its BIM objectives in a manner which helps eliminate risk from the project and which promotes collaboration, innovation and right first time design
- how the Supplier intends producing and delivering Information Artefacts in compliance with MMRCL standards

Post Contract:

As part of the Supplier post-contract BEP (BIM Execution Plan) and in addition to the pre-contract points listed above:

- how the Supplier intends developing the scope and delivery schedule for the MIDP (Master Information Delivery Plan) for agreement with MMRCL
- how the supplier intends to make sure that Information Artefacts are submitted in accordance with the MIDP, to the required schedule, LOD and quality
- how the Supplier intends publishing Drawing information to support Design Reviews, costing or any other identified purpose
- how the Supplier intends sharing and publishing Modelling information for Coordination and Collaboration purposes
- how the Supplier intends working collaboratively with interfacing disciplines and contracts in order to eliminate coordination issues, design clashes and constructability issues
- how the Supplier intends satisfying the Level of Definition (LOD) requirements

The EIR sets out Level of Definition requirements. This is a collective term used to describe both the '**Level of Model Detail**' and the '**Level of Information Detail**' 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 phase (for example during CONCEPT DESIGN, PRELIMINARY DESIGN, DETAILED DESIGN etc)

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

The LOD principles and requirements are set out in sections 3.4 and 3.5 respectively.

Note that this EIR document has been produced in alignment with BS1192 [Ref 2] and PAS 1192:2-2013 [Ref 3] and uses terminology consistent with this standard including:

- Task Team
- Master Information Delivery Plan (MIDP)
- Master Production Delivery Table (MPDT)
- BIM Execution Plan (BEP)

A glossary of key terms used in this EIR can be found in section 8 Definitions.

The following sections of this EIR document describe the Employers Objectives, the EIR Standards Methods and Protocols and Supplier obligations in more detail.

2. THE EMPLOYERS 5D BIM OBJECTIVES

It is MMRCL's objective to have a common strategy for the adoption of 5D BIM. The strategy includes an approach to describing information requirements across all aspects of the asset lifecycle with the Information Requirements (EIR) for such, being described in this document.

2.1 The Employer's Objectives

- To achieve a world-class quality of service, achieve efficiency and practice better control over the financial transactions and project activities
- Establish uniform standards for excellence in operations, project management, human resource management, financial management and performance reporting
- To drive efficiencies in the production, modification, operation and decommissioning of its engineered assets through data driven information, improving decision making and delivering best value to its stakeholders
- To institutionalise the use of the 5D BIM processes and solutions with the expectation that the solutions to become the backbone of the project during the design and build phase and subsequently for operations upon go-live of the project; with no change in the platforms envisaged unless the technology solution is declared obsolete and out of support

- To make sure that project execution stays within the defined timelines and budgets with the best of quality resulting from world-class practices on scheduling, estimation and engineering
- To institute good practise, collaborative techniques and behaviours which results in on-time and within budget project execution as follows:
 - A focus on design beyond 2D drafting and 3D modelling
 - Early visualisation and comprehension by MMRCL – enabling faster approval cycles
 - Ease of coordination between construction documents
 - Spatial Coordination between disciplines
 - Clash detection and conflict resolution limiting issues on-site and during construction.
 - Extraction of intelligent data and automated schedules
 - Ability to take-off materials and quantities
 - Ability to link Models, Projects Schedules and Construction Sequencing
 - Projecting future construction sequence conflicts
 - Tracking and identifying location of material and pieces on-site in a simulated environment
 - Transparent and realistic picture of the actual activities in the Project
 - Visualisation of construction-sites for contractors, sub-contractors and clients onsite
 - Integration of BIM with mobile-devices for managing construction and commissioning / hand-over.
 - View the current cost and compare it to the estimated total target cost of projects as well as interim costs against design during design phases
 - Effective strategic and operational setup right from the beginning of the Project
 - Implementation of an effective Operational Excellence in Initialisation & Execution
 - True and fair view on financials, reliable forecast and what-if-scenarios
 - Cost and Time optimised Program Management with early warning system in place for on-time management action
- To procure / produce, manage and maintain data and information about the MMRCL engineered assets that is complete, consistent and can be trusted and re-used for operational purposes and for future business intelligence

2.2 Project Objectives

The Employer's 5D BIM objectives for the Pune Metro Project / Contracts are to:

- achieve target capital delivery cost
- deliver best value through innovation
- obtain digital assurance and evidence, through the use of Information Artefacts, verifying the integrity and completeness of the design of the engineered solution at each stage of the Project / Contract
- obtain digital assurance and evidence, through the use of Information Artefacts, validating the buildability of the engineered solution

- obtain digital assurance and evidence, through the use of Information Artefacts, verifying that (and how) the asset(s) can be efficiently constructed / installed
- obtain digital assurance and evidence, through the use of Information Artefacts that health and safety and CDM requirements have been identified and met
- obtain digital assurance and evidence, validating the integrity and completeness of the (Handover) Information Artefacts
- obtain structured (Asset) data to populate Asset Management Information Systems

3. INFORMATION UTILISATION AND PLANNING

3.1 Primary Uses of Data and Information

The Employer's primary uses for the Information Artefacts, throughout the lifecycle of the asset(s), are as detailed in Table 3-1.

Table 3.1 – Primary Use	
Reference	Description
PU01	Assurance To verify that MMRCL assurance requirements are satisfied and evidenced
PU02	Project Coordination To verify coordination and integration between disciplines and with adjacent works / contracts
PU03	Business Case and Whole Life Cost To validate the business case and whole life cost forecasts, making sure they are robust and outcomes and benefits can be / will be achieved.
PU04	Cost Facilitate the population of the cost and estimating systems
PU05	Operations and Maintenance To validate that the assets will meet the operational and maintenance requirements as set out in the (Asset sections of the) Model Production and Delivery Table (MPDT)
PU06	Asset Registration To facilitate the asset registration process and subsequently populate the Asset Management Information Systems
PU07	Benefits Management To help verify that the project outcomes and benefits have been achieved

3.2 Stage Gate Digital Assurance

All Information Artefacts, as explicitly defined in the MIDP, shall be submitted to MMRCL using the MMRCL Common Data Environment (CDE), in order to:

- provide the requisite level of assurances in accordance with the Employers Requirements
- inform stage gate decisions, as defined below to enable Stage Gate sign-off:
 - **Stage 1: INITIATION**

Have business outcomes and benefits (that the projects must deliver) been established?
 - **Stage 2: CONCEPT DESIGN**

Are the business outcomes and benefits achievable?

Is there an option that delivers optimum value?
 - **Stage 3: PRELIMINARY DESIGN**

Have the design principles been defined?

Can the scope of the project be frozen?
 - **Stage 4: DETAILED DESIGN**

Will the designed solution deliver the required outcomes?

Can the detailed design be used for contracting delivery of the works?
 - **Stage 5: CONSTRUCTION (INSTALLATION)**

Have all (Production) Information Artefacts been provided and verified?
 - **Stage 6: HANDOVER**

Have all (Handover) Information Artefacts been provided and verified?

Have the assets been accepted by the end user?
 - **Stage 6: OPERATIONS**

Note: the table below provides a cross-reference between the generic project stages listed above and contract specific project stages

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7
	INITIATION	CONCEPT DESIGN	PRELIMINARY DESIGN	DETAILED DESIGN	CONSTRUCTION (INSTALLATION)	HANDOVER	OPERATIONS
Viaduct	Initiation	Concept Design	Preliminary Design	Detailed Design	Construction	Commissioning & Handover	Operation & Maintenance
Station	Initiation	Concept Design	Preliminary Design	Detailed Design	Construction	Commissioning & Handover	Operation & Maintenance
Traction	Initiation		Preliminary	Detailing	Material/ Equipment Procurement	Commission	Operations & Maintenance
					Installation & Testing		
Electrical & Mechanical	Initiation		Preliminary	Detailed	Procurement (Manufacturing & Inspection)	Testing & Commissioning	Operations & Maintenance
					Supply	Integrated Testing	
					Installation	Handing Over	
Telecom	Initiation	Concept	Preliminary	Detailed	Delivery	Interface test & Configuration	Revenue Operations Date
					Installation Test Procedures		
					Own Commissioning & Configuration	ITC (Final Testing)	
					Partial Acceptance		
					System Configuration	Trail Runs	
System Acceptance Test							
Rolling Stocks	Initiation	Preliminary	Pre-final	Detail	Mock	Integrated Testing & Commissioning	Operations
					Production		
					Testing & Commissioning	Trail Run	
Signalling	Initiation		Preliminary	Detail	FAT	Testing & Commissioning	Operations
					Delivery		
					Installation	As-Built	
Depot							
Track							

- facilitate the primary uses as set out in Table 3-1
- deliver the required types of documentation as part of the (Handover) Information Artefacts, as defined in the MIDP (Master Information Delivery Plan).

NOTE: The Supplier shall identify and capture within the MIDP, the Information Artefacts that will be delivered to support and inform the stage decisions and assurances, as set out within the **MMRCL Design Review and Acceptance Procedure** [Ref 6].

For details of the required types of documents to be delivered as part of the Handover Information, refer to the Operations and Maintenance section of the MIDP.

3.3 Technical and Design Reviews

All Technical and Design Reviews are to be undertaken in accordance with the **MMRCL Design, Review and Acceptance procedure** [Ref 6]. This procedure specifically identifies the types, frequency and events at which reviews will be undertaken.

The **MMRCL Design, Review and Acceptance procedure** [Ref 6] provides a comprehensive list of questions which are to be answered at each Design Review. The Supplier shall provide the agreed Information Artefacts needed to adequately answer all design review questions and provide the requisite evidence of assurance.

All Information Artefacts for Technical and Design Reviews shall be submitted by the Supplier through the CDE in accordance with the relevant **MMRCL EIR Standards, Methods and Procedures** [Ref 1]

3.4 LOD (Level of Definition) - Principles and Requirements

3.4.1 Purpose and Scope

The purpose of this section is to define the LOD principles and requirements for each of the primary systems and components within each Discipline for each project stage.

The Employer's LOD requirements are specified in the Employer's MDPT (Master Delivery Plan Table) – which is provided as a referenced document to this EIR document. The Employers MDPT declares:

- The list of systems for which models are required
- The project stage or stages (eg DETAILED DESIGN) at which models are to be developed by the Supplier

NOTE: see section 3.5 Master Production and Delivery Table (MPDT): The Employers Requirement, for the stages at which models are to be developed by the Supplier

- the required LOD for each of the systems models
- the intended purpose of the models
- the native and deliverable formats in which the models are to be issued to the CDE

NOTE: The Supplier shall develop the MIDP and BEP to provide assurances and evidence as to how the points above will be addressed

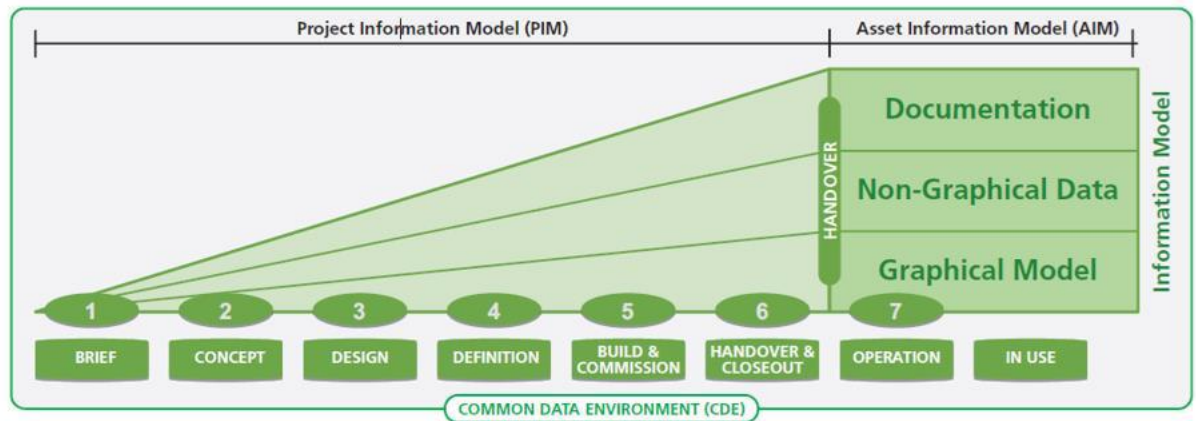
3.4.2 LOD Principles

The Level of Definition is a collective term used to describe both the '**Level of Model Detail**' [LOD] and the '**Level of Information Detail**' [LOI] 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 (for example during DETAILED DESIGN etc)

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 PAS1192-2 [Ref 3] as illustrated below:



In principle, the LOD and LOI and matures progressively throughout the project lifecycle as illustrated in the diagram below.

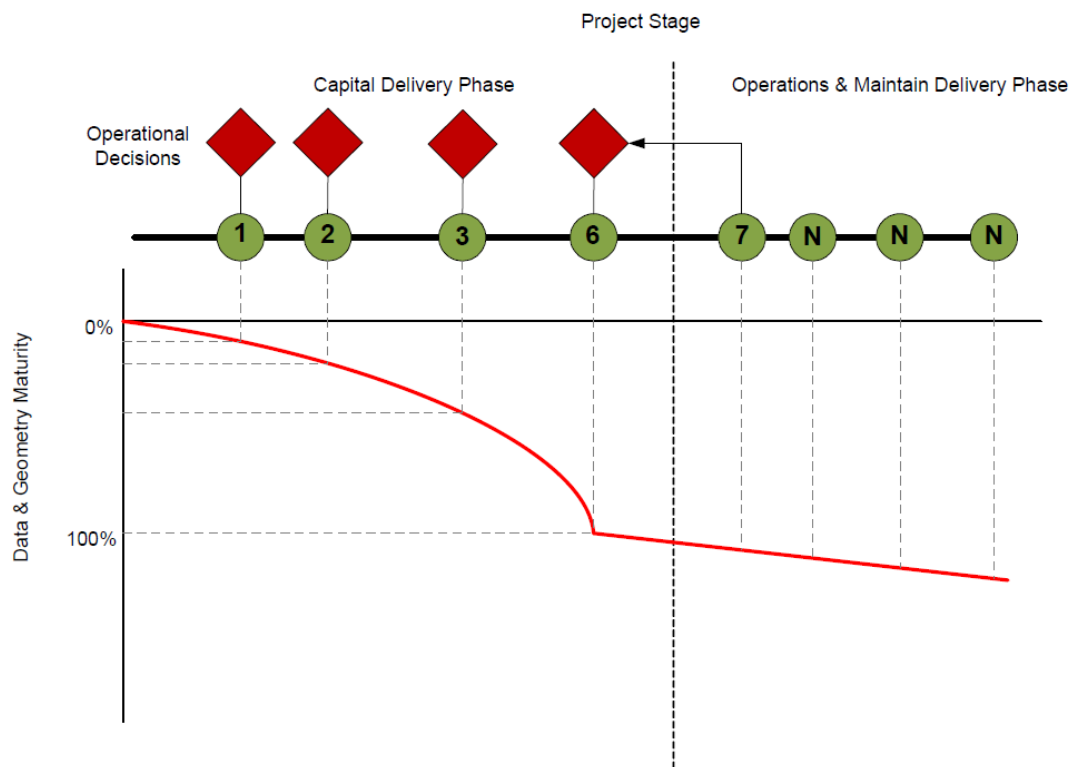


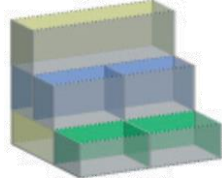

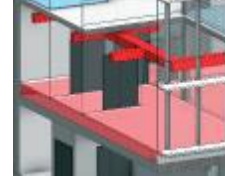





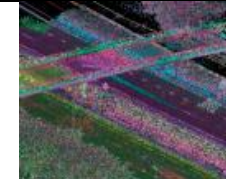


Figure 1. Plan of Work and the progressive Level of Definition.

Table 3.4.1 below declares MMRCL's overall vision and principles for modelling, LOD and LOI across the project lifecycle.

Table 3.4.1 - Generic principles of Levels of Model definition for building and infrastructure projects							
Stage Number	1	2	3	4	5	6	7
Model Number	INITIATION	CONCEPT DESIGN	PRELIMINARY DESIGN	DETAIL DESIGN	CONSTRUCTION	HANDOVER	OPERATIONS
Systems to be covered	N/A	As per MPDT requirements	As per MPDT requirements	As per MPDT requirements	As per MPDT requirements	As per MPDT requirements	As per MPDT requirements
Graphical Illustration (Building Project)							
Graphical Illustration (Infrastructure Project)							
What the model can be relied upon for	Model information communicating the brief, performance requirements, performance benchmarks and site constraints	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. Model content is not fixed and may be subject to further design development. The model can be used for co-ordination, sequencing and estimating purposes.	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. The model can be used for co-ordination, sequencing and estimating purposes including the agreement of a first stage target price	A dimensionally correct and model that can be used to verify compliance with regulatory requirements. 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 agreement of a target price/guaranteed maximum price.	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	An accurate record of the asset as a constructed at handover, including all information required for operation and maintenance.	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.
Output	Project brief and procurement strategy	Refined project brief and concept approval	Approval of coordinated developed design		Integrated production information. Complete fabrication and manufacturing details, system and element verification, operation and maintenance information Modify to represent as installed model with all associated references.	As constructed systems, operation and maintenance information. Agreed final account Building Log Book Information gathered as key elements are completed to feed installation information for the later packages.	Agreed final account. In use performance compared against Project Brief. Project process feedback: risk; procurement information management, soft landings

Stage Number	1	2	3	4	5	6	7
Model Number	INITIATION	CONCEPT DESIGN	PRELIMINARY DESIGN	DETAIL DESIGN	CONSTRUCTION	HANDOVER	OPERATIONS
Parametric Information	<p>Project needs update: definition of function(s), operation, quality and time.</p> <p>Benchmarking updated: capital cost, maintenance cost, time, health & safety, risk procurement contract.</p> <p>Performance requirements: Priorities and aspirations for: function, mix of uses, scale, location, quality, performance in use, cost (CAPEX & OPEX), value, time, health & safety, embodied and in use carbon, energy and resources needs, standard designs. Site constraints: geo-spatial, available site information.</p>	<p>Sufficient data to estimate per square metre rates and other similar metrics.</p> <p>Wireframe for surfaces/solids.</p> <p>Concepts, site context placeholder/ volumes/ package volumes, system routings, site selection, datum points & levels. Integrated concept for the project setting scope, scale, form and primary design criteria: architectural form and spatial arrangements, services philosophy and special arrangements preliminary assessment of energy use and embodied/in-use carbon, incorporation of standard systems</p>	<p>Co-ordinated Developed Design for the project setting: generic systems, objects, or assemblies represented with, detailed form, function, cost, defining all components in terms of overall size, typical detail, performance and outline specification, primary geometry frozen, integration of standard designs and systems, builders work strategy for significant interfaces, energy use, embodied and in use carbon.</p> <p>Maintenance plan Detailed design and construction program.</p>	<p>Production information for the project: Specific systems, objects and assemblies accurate in terms of specification, size, form, function and location. Critical interfaces flagged Fixing Methodology Confirmed clash free detailed production program sequence. Updated: energy use and embodied and in use carbon, detailed design and construction program</p>	<p>Production record for the project: Specific systems, objects and assemblies accurate in terms of specification, size, form, function and location with detailing, fabrication, assembly, and installation information Detailed routing of system Fixings and interfaces details to be used. Updated: energy use and embodied and in use carbon, detailed design and construction program.</p>	<p>Updated: Geometry and installed product information, "as constructed"</p> <p>Accuracy/resolution of information. Commissioned performance for: OPEX, energy, and carbon Detailed maintenance methodology. Snagging action status.</p>	<p>Revisions for modifications to the facility during its life.</p>
Employer activities							

Stage Number	1	2	3	4	5	6	7
Model Number	INITIATION	CONCEPT DESIGN	PRELIMINARY DESIGN	DETAIL DESIGN	CONSTRUCTION	HANDOVER	OPERATIONS
Critical Interfaces and logic	N/A	Environmental control philosophy and special allocations for ventilation; Availability of the site and outline construction methodology assumptions; Services capacity for the site Permitted working hours on site	Assumed procurement package performance ad spatial boundaries; Other relationships between procurement packages; Assumed design codes regarding dimensional tolerances of related systems; Foundation tolerances for use of off-site modular system; Assessment of predicted movements (thermal, loading, creep, shrinkage etc.)	Allocated procurement package relationships, performance and special boundaries; Actual dimensional interface requirements; Records of any derogations approved; Actual on-site to offsite interface specifications.	Progressive capture of actual dimensional data for critical interface dimensions. Progressive capture of information for calculating material requirements for follow on packages. Capture of object status for progress reporting and collaborative planning.	As constructed 3D scan Element performance test results. System Commissioning status.	As modified survey data.
Construction requirements (Examples)	N/A	Crane use zones; Traffic diversions	Confirmed crane (or other lifting system) zones framework details. Traffic diversion details.	Actual crane (or other lifting system) zones and movement sequences. Construction methodology, sequence and movements, critical to how the production design is developed.	Status of construction requirements. Safety briefing information. Construction methodology, sequence and movements, critical to installation. Formwork details including install and removal sequence. Actual traffic diversion details.	Confirmed status that the construction aids have been removed.	Design of any construction requirements, eg: temporary safety supports or restraint supports or restraint systems if structural defects have been discovered.
Project Costs	Initial project budget. Order of cost estimate.	Feasibility cost plan. Feasibility life cost plan.	Commitment Cost Plan. Contractor's first stage bid submission. Detailed whole life cost plan.	Contract Sum/Target price/ Agreed Maximum Price. Pre-construction whole life cost plan	Contract Sum/ Target Price/ Agreed Maximum Price. Pre-construction whole life cost plan.	Final account.	Actual in-use costs. Asset replacement sinking fund.
Project Logistics and off site activities (examples)	Client requirements, eg to avoid impact on other operations.	Assumed access and egress points; Potential delivery and lay down zones.	A feasible logistics sequence for the construction sequence; Confirmed modular strategy (volumetric, panelised, hybrid or other)	Finalised logistics sequences. Details of actual off-site system to be used.	Object status progress recording to initiate demand pull signals for deliveries.	Remote monitoring systems status.	Remote monitoring systems status.

Stage Number	1	2	3	4	5	6	7
Model Number	INITIATION	CONCEPT DESIGN	PRELIMINARY DESIGN	DETAIL DESIGN	CONSTRUCTION	HANDOVER	OPERATIONS
Project facilities (Welfare, IT Infrastructure, security etc) onsite and offsite (examples)	Collaboration tools; Data standards	Assumed access and welfare zones; Design team collocation.	Confirmed access zones and design team collocation.	Finalized, costed plan, Critical lead times confirmed. Off-site manufacturing capacity reserved.	Recording status of security critical areas (EG unchecked, sweep in progress, screened and secured)	Security system operational, potentially using model information for lines of sight from cameras, PAVA zone controls, etc.	Security system operational. Facilities management systems running on model generated information Geometry for letting activities accessed from "as constructed" model
Notes and associated project documents, based on model information	Management systems for information and decision making Approval policies.	Technical strategy studies. Commissioning philosophy NRM1 capital cost plan NRM3 maintenance cost plan	Provides the basis for Integrated Production Information to be produced on a package basis with limited risk of changes to primary coordination Room Information sheets, Detailed construction methodology NRM2 and NRM3 cost plans Health and safety risk management Risk Management plan.	Updated: maintenance plan, risk management plan, detailed construction methodology, NRM2 procurement pricing schedule, NRM3 maintenance cost an, health and safety risk management plan, risk management plan.	Detailed construction methodology, Updated health and safety risk management plan NRM3 maintenance cost plan	Approximate final account Maintenance procurement pricing Remedial works, handover and maintenance program.	N/A (project closed)

3.5 Master Production and Delivery Table (MPDT): The Employers Requirement

The Employers MPDT Requirements define the minimum LOD and LOI required for each System. These are explicitly defined in the Employers MDPT, which are referenced by to this EIR document.

NOTE: It is MMRCL's requirement that **model** Information Artefacts should be developed from the start of **DETAILED DESIGN** stage of the project. 2D drawings approved at the end of the preliminary stage should be used for developing the 3D Model which is only to be submitted for Review. On Final approval (Level A or Level B) of the 3D Model, 2D drawings are extracted and submitted for review with 3D drawings for Construction certification.

The Supplier shall develop the MIDP and BEP to provide assurances and evidence as to how the points below will be addressed:

- How models shall be developed to the required LOD/LOI.
- How models (and 2D drawings) shall be developed and issued to the CDE in the identified native and deliverable formats
-
- How the Supplier intends working collaboratively with interfacing disciplines and contracts in order to eliminate coordination issues, interface and design clashes and constructability and construction sequencing issues
- How all information artefacts (both models and drawings) shall comply with the **MMRCL - Engineering Assurance File Naming Convention** [Ref 5]
- How all information artefacts (both models and drawings) shall comply with the **MMRCL CAD Standard** [Ref 4]

3.6 Value Engineering

NOTE: The Supplier shall provide details of how Information Artefacts will be used to show the effectiveness (and provide assurance and evidence) of value engineering.

Value engineering must be integrated into the Design Review procedure. An MMRCL Operations Representative must have access to all relevant Information Artefacts and attend all value engineering reviews.

NOTE: The Supplier shall provide details of how Information Artefacts will be presented and approved during the review process.

3.7 Health and Safety and Construction Design Management (CDM)

NOTE: The Supplier shall provide details of how Information Artefacts will be utilised to support health and safety and CDM obligations; identifying, eliminating and reducing hazards and risks and providing better safety management.

Where the Supplier is contracted to carry out Detailed Design they shall provide details of process for integrating the construction plan with other components of the Production Information. Details shall include how safety measurements will be validated and how compliance with safety regulations will be checked.

3.8 Asset Information

Table 3-5 provides details of the Employer's corporate solutions for the management of Asset Information and the vehicle for delivery of the required information.

Table 3.5 – Asset Information		
Description		
System	Data / Information	Information Exchange Format
Bentley AssetWise	Documentation	Word/Excel/PDF
Bentley ProjectWise	Graphical Data	Refer to Table 6.2
	Non-Graphical Data	Excel

Note: Where the MMRCL MPDT Requirements extend to the CONSTRUCTION, HANDOVER or OPERATIONS phases, the Supplier shall develop and include a MDPT response within the Suppliers BEP providing assurances and evidence as to how the points below will be addressed:

- How Asset Information Artefacts shall be developed to the required LOD/LOI for each of the listed systems and project stages
- How Asset Information Artefacts (and 2D drawings) shall be developed and issued to the CDE in the identified native and deliverable formats
- How Asset Information Artefacts shall comply with the **MMRCL - Engineering Assurance File Naming Convention** [Ref 5]
- How Asset Information Artefacts (drawings) shall comply with the **MMRCL CAD Standard** [Ref 4]

3.9 Training Arrangements

The Supplier is responsible for making sure that their staff (and that of their Sub-contractors of any tier) are adequately briefed and trained to undertake the Information Management and Information Modelling aspects of the project.

The Supplier shall provide details of how they will make sure (and manage and maintain) their staff (and that of their Sub-contractors) have the capability and competency to provide verified and coordinated Information Artefacts in accordance with these EIRs.

4. STANDARDS, METHODS AND PROCEDURES

4.1 Standards

All Information Artefacts, as specified in the MPDT and as defined and agreed in the MIDP, shall be produced, managed and submitted into the CDE in accordance with the standards and procedures listed below and in any case in compliance with the **MMRCL EIR Standards, Methods and Procedures** [Ref 1].

Table 4.1 – Industry Standards		
Standard Ref	Title	Revision

BS 1192:2007+A2:2016	Collaborative production of architectural, engineering and construction information. Code of practice	N/A
BIP2207	Standard Framework and Guide to BS1192:2007	
PAS 1192-2:2013	Specification for information management for the capital/delivery phase of construction projects using building information modelling	
Digital Plan of Work (NBS Toolkit)	https://toolkit.thenbs.com/	
CIC BIM Protocol 2013		
Table 4.1 – Project Standards & Procedures		
Standard Ref	Title	Revision
MMRCL CAD Standard	MMRCL CAD Standard	V1.0

4.2 Security

NOTE: The Supplier shall provide details and assurances within the BEP of how the following potential security concerns will be addressed:

Note: that the scope and context of these security concerns relates to the Suppliers production and management of Information Artefacts, in particular when working outside of the MMRCL CDE

- How the Supplier will comply with all relevant MMRCL security policies
- How the Supplier will protect MMRCL IP (Intellectual Property)
- How the Supplier will make sure that access to Information Artefacts will be restricted only to the relevant, authorised personnel
- How the Supplier will protect Information Artefacts against malicious attack

4.3 Roles and Responsibilities

The role of a Project Information Manager shall be appointed by the Supplier.

The responsibilities of the Project Information Manager include:

- making sure that the BEP has been completed and agreed with the Employer and (where appropriate) briefed to Sub-contractors or suppliers of the Supplier and the relevant the Project / Task Team members
- making sure that the BEP is updated as works progress, in compliance with project change control procedures
- making sure that all Employer standards, methods and procedures are fully complied with
- promoting collaborative behaviours
- providing the focal point for all Information Artefact management issues on the project

-
- making sure that all Information Artefacts are compliant with the requirements of the contract and all relevant Employer standards
 - making sure that all Information Artefacts are managed and submitted through the CDE and that all mandatory meta-data has been populated
 - making sure that the Supplier, Sub-contractors or suppliers of the Contractor / Consultant, and the relevant the Project / Task Team members (as applicable) have continued and appropriate access to the Project Data Environment
 - providing clear instructions, including on the following areas:
 - which Information Artefacts are required, by whom and for what purpose;
 - who will generate the Information Artefacts and maintain them;
 - how Information Artefacts will be sorted and distributed;
 - how frequently Information Artefacts will be shared (for example for inter-disciplinary coordination purpose); and
 - what actions should be taken on receipt of Information Artefacts

The Roles and Responsibilities relating to the authoring, checking, sharing, publishing and management of the Information Artefacts can be found in the **MMRCL EIR Standards, Methods and Procedures** [Ref 1].

The Supplier shall assure MMRCL that that responsibilities have been adequately allocated and that a contact list of those assigned to the project, including Curriculum Vitaes (CV) is maintained for assurance purposes.

4.4 Naming Conventions

The Supplier shall make sure that a single File Naming convention is used for all Information Artefacts and that File Names are unique across the Project.

The File Naming Convention is defined in **MMRCL EIR Standards, Methods and Procedures** document [Ref 1].

4.5 Classification

The Supplier shall structure all Information Artefacts; categorising the functional and physical characteristics of the assets such that they can be efficiently identified, grouped and utilised

5. INFORMATION MANAGEMENT

5.1 System Performance and Constraints

The Supplier shall provide details of any limitations / restrictions of all IT systems; this should as a minimum determine limitations on files size and any restrictions on the use of the MMRCL recommended software platforms.

The Supplier is responsible for procuring, testing and implementing any required IT infrastructure, hardware and software in advance of project mobilisation and on-boarding.

5.2 Planning and Work Segregation

Zoning and Volume Strategy

The Contractor / Consultant shall provide details of their massing strategy in accordance with Section 3.4 **Level of Definition – Principles and Requirements** which shall define the extents of the proposed design, including:

- shape
- general size
- location
- orientation.

Modelling Strategy

The Supplier shall provide details of their modelling strategy, which must explicitly define how Information Artefacts will be developed to allow;

- parallel working across discipline / Task Teams
- coordination within (and across) interfacing disciplines / Task Teams and all adjacent works /contracts
- efficient Information Artefact exchange through the CDE
- delivery of graphical information in accordance with the **MMRCL CAD Standard** [Ref 4]

Volume Strategy

The Supplier shall provide details of their volume strategy, which must explicitly define how the extents of the massing strategy are sub-divided into spaces within which discipline / Task Teams can effectively coordinate their designs (i.e. rooms, horizontal and vertical circulation, structures, service routes).

The Supplier shall provide details of their processes for utilising the volume strategy to:

- federate models
- provide assurances and evidence of coordination between interfacing disciplines / Task Teams and all adjacent works / contracts
- design within each volume
- provide assurances and evidence of the coordination and integration between the volumes

Please refer to Section 3.4 **Level of Definition – Principles and Requirements** for more details.

5.3 Common Data Environment (CDE)

All Information Artefacts shall be authored, checked, shared, published and managed through the CDE, in accordance with **MMRCL EIR Standards, Methods and Procedures** [Ref 1] – but see qualifying notes below with respect to authoring and checking.

The CDE comprises:

- **A Project Data Environment**

MMRCL will provide a designated system accessible to all Task Teams and other relevant stakeholders (as authorised by MMRCL), which shall be used as a managed 'single source of truth' for all Information Artefacts **shared** for (non-contractual) coordination and collaboration purposes and for all Information Artefacts **published** for (contractual) MMRCL Design Review and Acceptance purposes

- **Task Team Data Environment(s)**

MMRCL will provide each Task Team with a dedicated, secure working area (the Task Team Data Environment) where Information Artefacts shall be Shared and Published, in accordance with the Master Information Delivery Plan (MIDP).

All Shared and Published Information Artefacts shall first be approved by the Task Team Manager before issue to the relevant Shared or Published Area of the Project Data Environment

All Shared and Published Information Artefacts shall first be approved by the Task Team Manager before issue to the relevant Shared or Published Area of the Project Data Environment

MMRCL shall provide the Project Data Environment as described in **MMRCL EIR Standards, Methods and Procedures** [Ref 1]. All other details relating to the Collaboration Tools used to support the CDE are documented below.

The Employer Collaboration tool is declared in Table 6.1a. Details of how the Supplier (and their Sub-contractors) shall access and interact with the system, including the security model, access rights and training and support to be provided is documented in the **MMRCL EIR Standards, Methods and Procedures** [Ref 1].

5.3.1 Task WIP (Work in Progress) Team Data Environment

Note that Suppliers may optionally choose to develop WIP Information Artefacts within the MMRCL Task Team Data Environment.

On request, MMRCL shall provide each Task Team with a secure WIP (Work in Progress) working area, where the Supplier can author and check Information Artefacts in advance of issuing to the relevant Shared or Published Area of the Project Data Environment should the Supplier choose to work this way – the Supplier shall notify and document this intent within the Suppliers BEP response

5.4 Collaboration Process

The Supplier shall make sure that all Information Artefacts are checked, approved and verified as Information Artefacts are issued to or are passed through the CDE.

The types of checks and approvals shall be determined by the purpose for which the Information Artefacts is being shared (refer to Section 8 of the SMP for further details).

The Supplier shall provide the following details:

- processes for checking, approving and verifying Information Artefacts within the CDE
- triggers for sharing / exchanging Information Artefacts
- purposes of sharing / exchanging Information Artefacts
- assurances of compliance against the prescribed information exchange format
- frequency and purpose of each design review / coordination workshop

5.5 Compliance Plan

The Supplier shall provide details and evidence of how Information Artefacts, delivered through the CDE, are:

- verified against Project Requirements (including the EIR)
- compliant with the standards set out in section 4.1,
- progressed to the agreed LOD as set out in the MIDPs and BEP
- spatially coordinated in relation to the assets physical space, operational space and maintenance space
- useable by the software platforms identified in Table 6-1
- in the information exchange formats identified in Table 6-2; and
- checked and approved for technical content, in accordance with the MMRCL Design, Review and Acceptance Procedure [Ref 6]

6. DIGITAL ENGINEERING

6.1 Software Platforms

6.1.1 Collaboration Platforms

The Employers Collaboration Platforms are listed in Table 6-1.

Table 6.1 – Employer Collaboration Platforms		
Use	Platform	Version
CDE: Project Data Environment – Collaboration Tool	Bentley ProjectWise	
CDE: Project Data Environment – DMS (Document Management System)	Bentley AssetWise	
3D/4D/5D integration	RIBiTwo	
Project Scheduling	Primavera	
Enterprise Reporting	SAP	

6.1.2 Content Development and Analysis Platforms

The Employer shall not place any restrictions on the content development or analysis tools to be used by the Supplier.

However, in order to minimise compatibility and interoperability issues, the Employers mandates that any DWG format which is issued to the CDE is published using AutoCAD version 14 or higher.

The Supplier shall document assurances to this affect through the BEP response.

6.2 Information Exchange Formats

The Supplier shall deliver Information Artefacts (issued through the CDE), in accordance with the MIDP and in the exchange formats declared in Table 6-2 and where appropriate in accordance with ***NRMCL CAD Standard*** [Ref 4].

Data/Information	Exchange Format
Documentation	PDF, DOC, XLS
2D Drawings (Design & Construction)	DGN, PDF
2D Drawings (As Built & Operations & Maintenance)	DGN, PDF
Native 3D discipline based models (Graphical Data)	DGN
Deliverable 3D models (Graphical Data)	iModel
4D Simulation (Graphical Data and Non-Graphical Data)	iModel, DGN
Survey data (for Design & Engineering context)	3MX, CSV, SHP
Cost Data (Non-Graphical Data)	XLS
Programs	XER, PLF, MPP, PDF, XLS

If necessary, the Supplier shall provide details of how interoperability issues will be addressed to make sure that Information Artefacts are delivered in the formats prescribed above.

6.3 Coordinates

All geographical Information Artefacts shall be exchanged, through the CDE, in compliance with the MMRCL Project Grid:

- Survey information, including mapping
- All Information Artefacts which represent the fixed geographical location of an asset or assets.

Details relating to the MMRCL Project Grid are listed below:

Geographic Coordinate System Properties	
Coordinate System	
Name	UTM84-44N
Description	UTM-WGS 1984 datum, Zone 44 North, Meter, Cent. I
Projection	Universal Transverse Mercator
Source	Snyder, J.P. 1987, Map Projections - A Working Man
Units	Meter
UTM Zone	44
Hemisphere	Northern
Minimum Longitude	77°30'00.0000"E
Maximum Longitude	84°30'00.0000"E
Minimum Latitude	01°00'00.0000"S
Maximum Latitude	84°00'00.0000"N
Datum	
Name	WGS84
Description	World Geodetic System of 1984
Source	US Defense Mapping Agency, TR-8350.2-B, Deceml
Conversion Method	WGS84 - no shift required
Ellipsoid	
Name	WGS84
Description	World Geodetic System of 1984, GEM 10C
Equatorial Radius	6378137
Polar Radius	6356752.3142
Eccentricity	0.081819190928906743
Source	US Defense Mapping Agency, TR-8350.2-B, Deceml
Coordinate System Modifiers	
Vertical Datum	Matches Datum
Local Transform Type	No Transform

Details relating to the dimensional consistency / units of measure are found in the **MMRCL CAD Standard** [Ref 4].

7. COMMERCIAL REQUIREMENTS

The Supplier shall respond to this EIR in the form of a BIM Execution Plan (BEP); the template for which shall be provided by MMRCL.

8. DEFINITIONS

Table 8 – Definitions	
Term	Definition
Asset Management Information System	Systems used to store and manage data about assets.
BEP (BIM Execution Plan)	A document within which the proposed approach, capability, capacity and competencies of the prospective or selected Contractor / Consultant sets out the response to the EIRs
CDE (Common Data Environment)	The agreed solution for the production, use and management of Model File(s), Composite Model(s), Non-Graphical Data, Document Definition(s) and Document Rendition(s), as set out in the SMP, BEP and MIDP(s)
Composite Model	Computer Aided Design (CAD) file(s) displaying one or more Model Files (attached as references), for the purpose of performing coordination activities and / or compiling Document Definitions.
Data Authoring	Creation of Production Information and Handover Information
Data Capture	Collecting, from various sources, Graphical Data and Non-Graphical Data relating to asset(s)
Data Coordination	Use of Graphical Data and Non-Graphical Data, about the asset(s), to virtually assure and evidence coordination across all task teams, existing infrastructure and adjacent works
Data Simulation	Use of Graphical Data and Non-Graphical Data to virtually test the design, construction, operation and maintenance of the asset(s)
Data Validation	Rule based tools used to validate and check all Production Information and Handover Information against the EIR and Standards
Data Visualisation	Visually representing Graphical Data and Non-Graphical Data to support decision making.
Document Definition	Data file produced, containing a view of the Non-Graphical Data and / or Model File(s) and / or Composite Model(s), to derive meaning for a specific purpose
Document Rendition	A data file in an immutable format, derived from a Document Definition
Handover Information	Model File(s), Composite Model(s), Non-Graphical Data, Document Definition(s) and Document Rendition(s) which have been agreed between the Parties to be produced, updated, maintained and delivered as set out in the Master Information Delivery Plan(s) in accordance with the Employers requirements
Information Artefacts	The collective term for Production Information, Handover Information and any other model or drawing deliverables identified in the within the MIDP and MPDT – all Information Artefacts shall be authored, shared, published and archived within the CDE

MIDP (Master Information Delivery Plan)	A forward looking schedule of the Model File(s), Composite Model(s), Non-Graphical Data, Document Definition(s) and Document Rendition(s) which are to be produced, maintained and delivered as Information Artefacts
Model File	Computer Aided Design (CAD) file(s) containing shape(s) with defined origin, orientation and dimensions, communicating the physical characteristic of the assets. A Model File may also include Non-Graphical Data, associate to the CAD file(s) and / or shape(s), identifying the functional characteristics of the asset(s)
Non-Graphical Data	Data file containing alphanumeric characters, communicating the physical and functional characteristics of the asset(s)
Primavera	MMRCL Project Planning Tool
Production Information	<p>The Model File(s), Composite Model(s), Non-Graphical Data, Document Definition(s) and Document Rendition(s), including Engineering Information which have been agreed between the Parties to be produced, updated and maintained in order to provide the Works and be delivered during the design and construction stages of the Project, as set out in the MIDP(s).</p> <p>Referred to within PAS1192-2 as the PIM (Project Information Model).</p>

MMRCL EIR Standards, Methods and Procedures



Document Status	
Document Title	MMRCL EIR Standards, Methods and Procedures
Document Number	MMRCL-Pune Metro-SMP V1.0
Publication Date	20-April-2017
Issue Status	For MMRCL acceptance
Prepared by	
Reviewed by	
Approved by	

Revision Status			
Date	Revision Made	Revision by	Approved by

References			
No	Title	Version	Date
1	MMRCL-Pune Metro-EIR V1.0	2007 + A2	20-April-2017
2	BS1192:2007+A2:2016 Collaborative production of architectural, engineering and construction information. Code of practice		2016
3	PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling		2013
4	MMRCL CAD Standard	V1.0	20-April-2017
5	MMRCL - Engineering Assurance File Naming Convention	V1.0	20-April-2017
6	MMRCL Design Review and Acceptance Procedure		20-April-2017
7	MMRCL Master Information Delivery Plan Template (MIDP)	V1.0	20-April-2017
8	MMRCL Master Delivery List (MDL)	V1.0	20-April-2017
9	MMRCL Master Production Delivery Table (MPDT)	V1.0	20-April-2017
10	MMRCL Level 2 BIM E2E Workflow Process	V1.0	20-April-2017
11	MMRCL Level 3 Drawing Process	V1.0	20-April-2017
12	MMRCL Level 3 Model Process	V1.0	20-April-2017

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1. PURPOSE

The purpose of this document is to set out the MMRCL SMP (**Standards, Methods and Procedures**), for the Pune Metro Project, including those relating to the MMRCL CDE (Common Data Environment), the means by which Information Artefacts, as set out in the MIDPs (Master Information Delivery Plans), are to be produced, used and managed.

The intent is to provide a common set of processes (including those in relation to the Common Data Environment) for the production, use and management of the Model Files, Composite Models, Non-Graphical Data and Document / Drawing Renditions.

This document shall be read in conjunction with **MMRCL-Pune Metro-EIR V1.0** [Ref 1], **BS1192:2007+A2:2016** [Ref 2] and **PAS 1192-2:2013** [Ref 3].

2. SCOPE

This SMP applies to all parties (including the Employer) involved in the Pune Metro Project, who are engaged in the production, use and management of Information Artefacts as set out and agreed in the MIDP(s).

3. PROJECT DOCUMENTS

See Appendix A: Document Map for the relationship between this and other EIR related documentation.

4. MASTER INFORMATION DELIVERY PLAN

The Supplier / Detailed Design Consultant / Contractor [**the Supplier**] shall provide one MIDP per organisation, per organisational role (as applicable).

The MIDP shall be populated and agreed and included as part of the Suppliers BEP response, during the mobilisation period, prior to commencement of any production information.

Note that all updates to the MIDP shall follow project change control procedures.

5. COMMON DATA ENVIRONMENT (CDE) PROCEDURES

5.1 General

The Supplier shall produce, use and manage all Information Artefacts in accordance with the procedures set out in Section 5.2 below.

The CDE comprises:

- **A Project Data Environment**

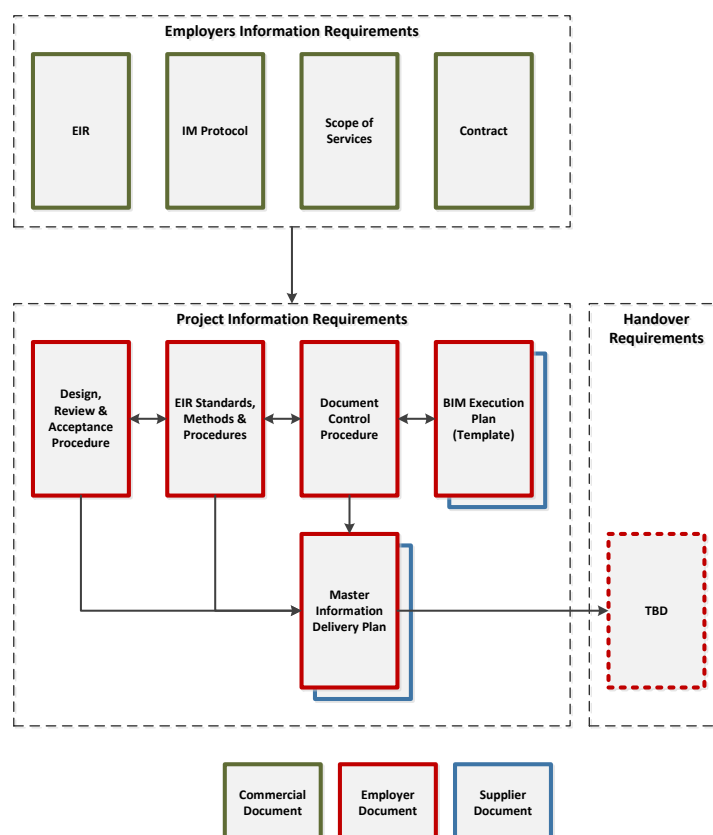
MMRCL will provide a designated system accessible to all Task Teams and other relevant stakeholders (as authorised by MMRCL), which shall be used as a managed 'single source of truth' for all Information Artefacts **shared** for (non-contractual) coordination and collaboration purposes and for all Information Artefacts **published** for (contractual) MMRCL Design Review and Acceptance purposes

- **Task Team Data Environment(s)**

MMRCL will provide each Task Team with a dedicated, secure working area (the Task Team Data Environment) where Information Artefacts shall be Shared and Published, in accordance with the Master Information Delivery Plan (MIDP).

All Shared and Published Information Artefacts shall first be approved by the Task Team Manager before issue to the relevant Shared or Published Area of the Project Data Environment

Note that on request, MMRCL will provide each Task Team with a secure WIP (Work in Progress) working area, where the Supplier can author and check Information Artefacts in advance of issuing to the relevant Shared or Published Area of the Project Data Environment should the Supplier choose to work this way – the Supplier shall notify and document this intent within the Suppliers BEP response.



Please refer to

5.2 CDE Procedure

5.2.1 Task Team WIP (Work in Progress) Area (Optional)

Note that Suppliers may optionally choose to develop WIP Information Artefacts within the MMRCL Task Team Data Environment.

On request, MMRCL shall provide each Task Team with a secure WIP (Work in Progress) working area, where the Supplier can author and check Information Artefacts in advance of issuing to the relevant Shared or Published Area of the Project Data Environment should the Supplier choose to work this way

The Task Team WIP Area of the CDE is where a Task Team can develop content using their organisations systems and tools. This is the only area of the CDE where Information Artefacts are to be produced and / or edited.

Access to each Task Team's WIP Area shall be restricted to those Task Team members who are authorised (by the Task Team Manager) to author Information Artefacts. Information Artefacts within this area of the CDE are not to be disseminated or used by other Task Teams, or the Employer, for any purpose.

All WIP Information Artefacts shall carry a preliminary revision that includes the major revision and minor version and the suitability 'S0 – Non Verified Data' (refer to Appendix D: CDE – High Level Workflow).

Before Information Artefacts are shared with other Task Teams and other parties including the Employer, the Task Team Manager shall make sure that all checks and reviews, as applicable for the purpose for which the Information Artefact is being shared (as set out in Section 8), have been carried out. The Task Team Manager shall then approve the Information Artefacts for issuing to the Project Shared Area (forming part of the Project Data Environment).

Before issuing Information Artefacts to the Project Shared Area, the Task Team Manager shall make sure that the applicable suitability code and revision have been designated (refer to Section 8).

5.2.2 Project Shared Area

The purpose of the Project Shared Area (of the Project Data Environment), is to serve as a 'single source of truth' for each Task Team's issued Information Artefacts. Only Information Artefacts within this area of the CDE are to be referenced by other Task Teams and other parties including the Employer. The Information Artefacts are to be used in accordance with assigned suitability codes. Refer to **MMRCL CAD Standard** [Ref 4] for a list of suitability codes.

Only Information Artefacts with applicable suitability code and revision, refer to **MMRCL CAD Standard** [Ref 4], that have been approved by the applicable Task Team Manager are to be held within the Project Shared Area of the CDE.

All Information Artefacts in the Project Shared Area of the CDE shall be read-only and shall not to be edited by any Task Team or any other party (including the Employer).

Where changes to the Information Artefacts are required, a new version shall be created and the revision incremented, '+1' and the minor version reinstated. Refer to **MMRCL CAD Standard** [Ref 4]. The new version shall be placed in the Task Team WIP Area and the old version retained in the Project Archive Area of the CDE.

Before accepting the Information Artefacts and issuing to the Project Published Area, the Project Manager shall make sure that:

- all relevant approvals are in place and the acceptance criteria have been met
- the applicable suitability code and revision have been assigned

5.2.3 Project Published Area

As part of the Project Data Environment, the Project Published Area of the CDE holds all the Information Artefacts which have been accepted by the Project Manager.

Only Information Artefacts that have been accepted, meet the acceptance criteria and have been assigned an applicable suitability code and revision (refer to **MMRCL CAD Standard** [Ref4]) are to be held within the Project Published Area.

All Information Artefacts in this area of the CDE shall be read-only and shall not to be edited by any Task Team, or any other party (including the Employer).

Where changes to the Information Artefacts are required a new version of the file shall be:

- created, its revision incremented, '+1' from its previous revision and the minor version reinstated (refer to **MMRCL CAD Standard** [Ref 4])
- placed in the WIP Area and the old version retained in the Archive area of the CDE

5.2.4 Archive

The Archive area of the CDE (within both the Task Team Data Environment and Project Data Environment) shall hold inactive and / or superseded Information Artefacts.

Information Artefacts in the Archive area are not to be amended or updated.

5.3 Information Security and Access

5.3.1 General

Security and access to the data and information held in each area of the CDE shall be assigned according to CDE Roles and Competencies.

5.3.2 CDE Roles and CDE Competencies

All Task Team members and other parties including the Employer's team shall be assigned to a CDE Role as defined in Section 7. Access to the Area(s) of the CDE shall be determined by these Roles.

Persons who are required to perform specific tasks (create, edit, approve, or accept) in a given area of the CDE shall be assigned the appropriate CDE Role.

Note: Although a project team member can be assigned one or more Competency, they shall not approve Information Artefacts that they have authored.

6. INFORMATION EXCHANGES

6.1 Task Team Data Environment

When Information Artefacts to be shared with others shall be:

- approved by the Task Team Manager
- issued to the Project Data Environment and a version retained in the Task Team Shared Area

6.2 Project Data Environment

Information Artefacts shall only to be shared with other Task Teams or other parties include the Employer, through the Project Data Environment.

Information Artefacts to be shared, can be copied from the Project Data Environment to the Task Team's Shared Area for (read-only) use, in accordance with the assigned suitability.

The MMRCL CDE is to be used as the Project Data Environment. The Project Data Environment has been configured to allow all Task Team Managers and the Employer to issue Information Artefacts, approved by the Task Team Manager, to the Project Shared Area; all other Task Team members have read-only access to the Project Shared Area.

Information Artefacts shall be shared, as a minimum:

- when a change to the design occurs which may impact another Task Team
- when a Task Team needs more space than that which has been allocated in order to meet design requirements and / or connection points / location of integration changes
- for design review meetings
- at each of the agreed project stages (in line with the Accepted Programme), at which time the Production Information and / or Handover Information shall be in accordance with MMRCL Standards (see Section 12.1).

Details of information exchanges between the Supplier and Sub-contractor(s) are to be included within the BIM Execution Plan, to be provided by the Supplier.

6.3 Supplier Responsibility

Before publishing Information Artefacts to the Project Shared Area Task Team Managers shall:

- make sure that Information Artefacts are review and checked in accordance with the suitability code for which Artefact is being shared
- make sure that the appropriate suitability code is assigned
- make sure that the appropriate revision code is assigned
- make sure that all mandatory metadata is assigned

In addition to the above, the Supplier shall make sure that all Information Artefacts, to be shared for Employer review and acceptance are:

- developed to a level of detail, as agreed within the MDPT and in accordance with agreed acceptance criteria
- checked, reviewed and approved in accordance with all relevant standards
- delivered in accordance with agreed project dates, the MIDP(s), MDPT, SMP and BEP

6.4 Site Information (including Survey)

6.4.1 Site Information

If Site Information is to be provided to the Supplier then this shall be documented within the MIDP and issued as part of the tender documents.

A list of the available Site Information to be provided by the Employer, along with its suitability for purpose, shall be documented in the MIDP by the Employer.

All Site Information shall be distributed through the Employer's Project Data Environment.

6.5 Employer Document Control (Employer use only)

The following systems are the Employer's internal solutions for the management of Information Artefacts.

Table 6.1 – Data / Information Systems		
System	Data	Contact
Bentley AssetWise	Non-Graphical Data and Document renditions	OSO
Bentley ProjectWise	CAD data	OSO
CMS (TBD)	Non-Graphical Data	OSO

All Information Artefacts, as per the agreed MIDP shall be distributed, by the Employer's Document Controller, through the applicable system (as per Table 6-1).

7. ROLES AND RESPONSIBILITIES (for Information Artefacts)

The purpose of this section is to define the roles and responsibilities anticipated to be required in order to produce and manage Information Artefacts. The emphasis is on ownership, responsibility and authority. These are in addition to roles and responsibilities already defined within the contract.

The Supplier shall maintain a list of persons assigned to each of these roles. It should be noted that project team members can be allocated one or more of these responsibilities as necessary.

7.1 Design Coordination Manager (appointed by the Supplier)

The Design Coordination Manager (also known as the Design Manager on some contracts) responsibilities include:

- providing the single point of contact for all communications between the design and construction teams
- making sure that all design deliverables, including that of sub-contractors, designers and specialist designers are integrate with the construction programme

-
- making sure that that design deliverables are delivered in accordance with the agreed programme and MIDP(s).

7.2 Lead Designer (appointed by the Supplier)

The Lead Designer responsibilities include:

- making sure that all Information Artefacts have been listed in the MIDP(s) and agreed by all parties
- making sure that the project Zones (used to segment the project into manageable subdivisions) are defined and maintained for the duration of the works (it is anticipated that a shared Zone Model File shall be maintained for this purpose)
- managing coordination and integration of the design, including the development and approvals of the Information Artefacts
- making sure the design is fully co-ordinated and integrated across all disciplines, existing infrastructure and any adjacent works
- Make sure all Information Artefacts are strictly controlled and shared through the Project Data Environment

7.3 Task Team Managers (appointed by the Supplier)

The Task Team Manager responsibilities include:

- the production of the design output for a particular task, or set of tasks allocated to the Task Team
- making sure that all checks and reviews, as applicable for the purpose for which the Information Artefact is to be shared (refer to Section 8), have been carried out
- approving of the Task Team Information Artefacts for issuing to the Project Shared Area
- providing authorisation for access to the Task Team WIP Area

7.4 Interface Manager (appointed by the Supplier)

The Interface Manager responsibilities include:

- as part of the Task Team, managing the spatial interface with other Tasks (the volume strategy determines the spatial allocation for each Task Team)
- proactively proposing resolutions to co-ordination clashes

For example: If a task requires additional space (i.e. the mechanical task team need to increase the area required for ventilation units) the interface manager for that task will discuss the impact of making additional space available with interface managers whose tasks are/or maybe affected

7.5 Project Information Manager (appointed by the Supplier)

The Project Information Manager responsibilities include:

- making sure that the BEP:
 - has been completed
 - is agreed with the Employer
 - is briefed to all Task Teams and other Parties including the Employer
 - is managed through the project change control procedures
- making sure that project processes are fully complied with and that collaborative behaviours pervade across the project
- providing the focal point for all Information Artefacts management issues on the project
- making sure that all Information Artefacts are compliant with the requirements of the contract and all applicable MMRCL Standards
- making sure that all Information Artefacts are managed through the CDE including that all mandatory meta-data have been captured and populated
- making sure that the Supplier, sub-contractors or supplier of the Supplier and others (as applicable) have continued and appropriate access to the Project Data Environment
- providing clear instructions to the Project Team including on the following areas:
 - what Information Artefacts are required, by whom and for what purpose
 - who will generate the Information Artefacts and maintain them
 - how it will be sorted and distributed
 - how frequently it is shared
 - what actions should be taken on receipt of the Information Artefacts

7.6 CAD Coordinator (appointed by the Supplier)

The CAD Coordinator responsibilities include:

- making sure that there is a consistent approach to modelling assets physical and functional characteristics across the project
- coordinating the project needs for IT solutions
- responsibility to the Task Team Managers and the Project Information Manager

7.7 CAD Manager (appointed by the Supplier)

CAD Manager responsibilities include:

- making sure that CAD Information Artefacts are compliant with agreed standards
- making sure that all CAD files are shared using the agreed IT solutions

7.8 Project Manager (appointed by the Employer)

The Project Manager responsibilities include:

- Making sure that that only compliant Information Artefacts are accepted and if applicable, making sure that any concessions required are in place before hand

7.9 Designated Technical Lead / Manager (appointed by the Employer)

The Designated Technical Lead / Manager responsibilities include:

- Registration of notifications and submittals
- Making sure that the Information Delivery Plan (comprising the Task Information Delivery Plan and Modelling Information Delivery Plan) covering submittals from the Supplier has been prepared
- Distributing within GC and MMRCL as appropriate
- Distributing to internal parties including Operations and Maintenance and external parties through MMRCL as required
- Collating comments and responses and convening working group meetings with the Supplier to resolve issues in presence of MMRCL representatives wherever required and receive resubmissions as required
- Convening technical, cost, value management and programming meetings within GC and MMRCL to properly review the content of deliverables
- Preparing reports on submissions, summarizing key issues, cost variations and programming impacts with associated recommendations

7.10 Lead Reviewer (appointed by the Employer)

The Lead Reviewer responsibilities include:

- Preparing a check list of reviewable data and inputs required by/from other disciplines
- Responding to the deliverables by the stipulated deadlines, and signing off as acceptable or otherwise each aspect of the design submission
- Delegating responsibility for acceptance and sign-off in cases of leave or other absence
- Identifying other parties or reviewers that require to have input into the review
- Reviewing comments provided by reviewers before issuing to back to the Supplier

7.11 Employer Information Manager (appointed by the Employer)

The Employer Information Manager responsibilities include:

- Completing, maintaining and implementing this document and making sure that it is available to all Task Teams and other Parties including the Employer
- managing the processes for information exchanges between the Supplier and Employer
- making sure that project processes are being followed by all Task Teams and other Parties, including the Employer
- providing the focal point for Information Modelling and Management issues

-
- making sure that collaborative behaviours are embraced

7.12 Document Controller (appointed by the Employer)

The Document Controller responsibilities include:

- making sure that project document control procedures are being followed by all Task Teams members and any other relevant Parties
- making sure that all Information Artefacts are delivered using the agreed IT solutions
- making sure that only Information Artefacts listed and agreed to be delivered in the MIDP(s), are delivered and accepted
- making sure all Information Artefacts, accepted by, or on behalf of the Project Manager, are distributed to the applicable MMRCL system (refer to Section 6.5)

8. INFORMATION ARTEFACTS: CHECKS, APPROVALS & ACCEPTANCE

8.1 Checks and Approvals

Before any Information Artefact is issued to the Project Shared Area, it shall first be checked and approved by the Task Team Manager. The level of checking and approval required will depend on the purpose for which the Information Artefact is being shared.

See Appendix D: High Level Workflow

- **Sharing for Coordination**

Information Artefacts shall be shared for coordination purposes (with the suitability, S1 – Issued for Coordination) in accordance with the MIDPs.

Before being issued to the Project Shared Area, all Information Artefacts to be shared for coordination purposes shall be:

- checked and verified against all applicable data and information standards (including the SMP and BEP)
- checked for technical content (in accordance with the Design Management Plan)
- approved for issue by the Task Team Manager

Information Artefacts, which have been shared for coordination, shall be used by other Task Teams and / or stakeholders to coordinate their design

- **Sharing for Review and Comment**

Information Artefacts shall be shared for review and comment purposes (with the suitability 'S3 - For Review and Comment') in accordance with the MIDPs.

The Circumstances under which Information Artefacts are issued for review and comments shall be specifically identified within the MIDPs but these may include:

-
- If there is a change to a Task Team's design which potentially impacts on other Task Teams and / or stakeholders
 - the Task Team requires additional space than that already allocated and / or connection points
 - The Task Team requires location integration changes

Where Information Artefacts are to be used, for example in Design Reviews, Coordination meetings, Inter-Disciplinary Design Review, Inter-Disciplinary Design Checks, they shall be shared for comment.

Before being issued to the Project Shared Area, all Information Artefacts to be shared for review and comment purposes shall be:

- checked and verified against all applicable data and information standards (including the SMP and BEP)
- checked for technical content (in accordance with the Design Management Plan)
- approved for issue by the Task Team Manager

Task Teams and / or other Parties, including the Employer, shall comment as applicable to make sure issues are identified and resolved.

Note that, Task Teams and / or other Parties, including the Employer, shall not change or coordinate their design based on Information Artefacts which have been issued for Review and Comment.

- **Sharing for Employer Review and Acceptance**

Information Artefacts shall be shared for Employer Review and Approval (S4 – Issued for Approval) in accordance with the MIDPs.

At the agreed project stages, as captured in the MIDP(s) and aligned with the accepted programme, Information Artefacts shall be shared using the suitability, S4 – Issued for Approval.

Before being approved, by the Task Team Manager and published to the Project Shared Area for Employer Review and Acceptance, the Supplier shall make sure that all Information Artefacts:

- are checked and verified against all applicable data and information standards (including the SMP and BEP)
- have the technical content checked (in accordance with the agreed DMP)
- meet design requirements (appropriate for the stage of the project at which it is being accepted)
- comply with all applicable MMRCL Standards
- are developed to the Level of Development, agreed within the MIDP(s)
- are approved by the Lead Designer as a coordinated and complete dataset; CAD files, Non-Graphical Data and Documentation cross-referenced and aligned
- all Model File content is approved by the Lead Designer as being spatially coordinated

8.2 Employer Acceptance

Prior to Information Artefacts being accepted by the Project Manager and moved to the Project Published Area (of the Project Data Environment), all acceptance criteria shall be in place; and any comments returned to the Supplier for incorporation prior to acceptance.

When accepted, the Employer shall move the Information Artefacts to the Project Published Area, in accordance with the Document Control procedure.

Document Renditions are **NOT** to be accepted until the Model File(s), Composite Model(s), Non-Graphical Data and Document Definition(s) used to produce them have first been accepted.

9. UNIQUE FILE IDENTIFICATION

All Information Artefacts shall be allocated a unique file identifier (file ID).

The file ID shall be composed of joining the fields (metadata) as defined in compliance with the **MMRCL - Engineering Assurance File Naming Convention** [Ref 5]

10. METADATA

In addition to the metadata required for the unique file ID, all Information Artefacts shall be attributed the metadata shown in Table 10-1.

Table 10.1 – Mandatory Metadata	
Field	Example
Unique File Identification	See Section 9 Unique File Identification
Revision	P04
Suitability	S3 (For Comment)
Title	Station Lift Shaft 1
Created (Author)	
Approved	
Authorised	
Grid Reference System	MMRCL Project Grid
Security Classification	MMRCL Restricted

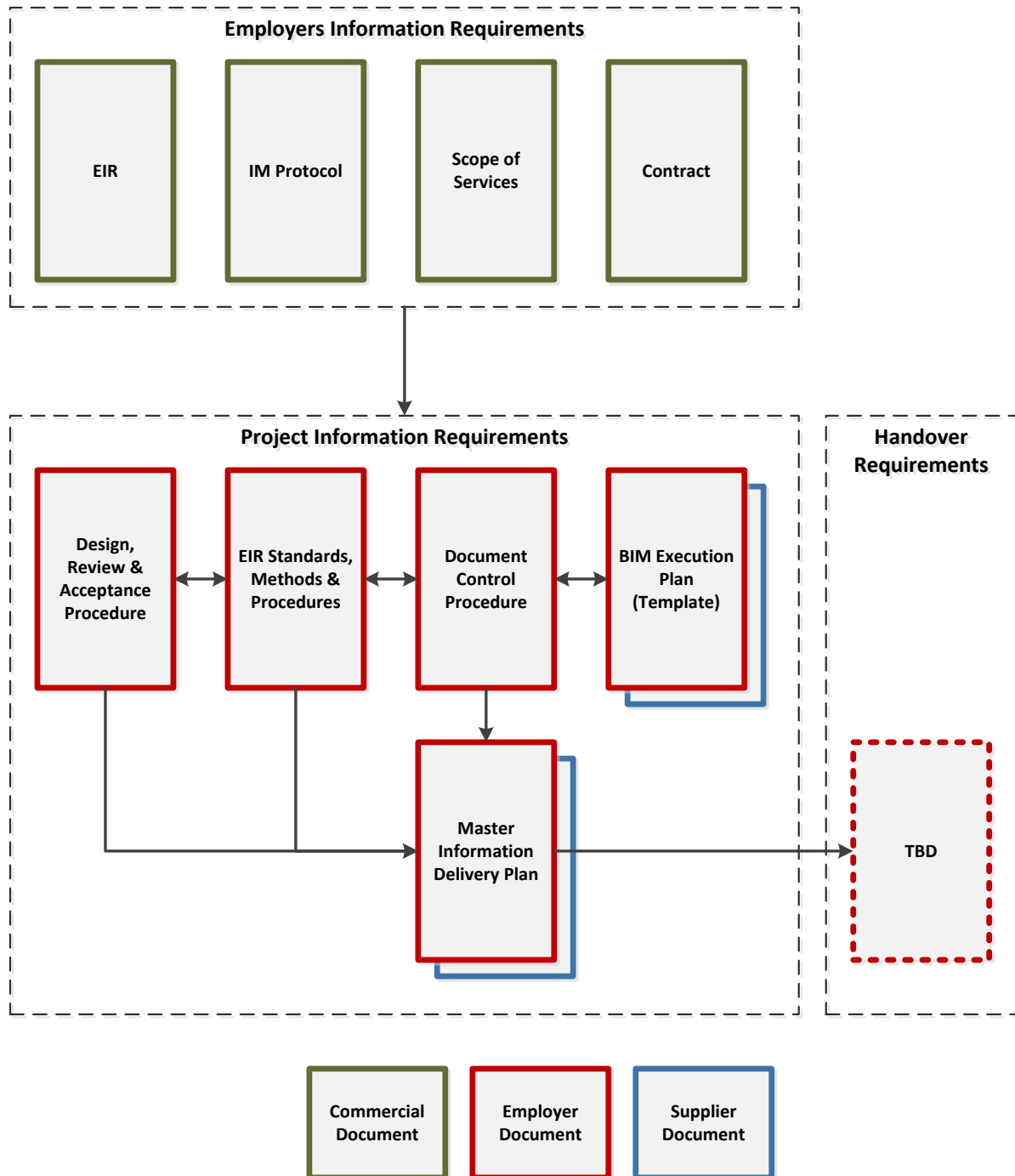
Lifecycle Stage	Detailed Design
Project / Contract	

11. DEFINITIONS

Table 12.1 – Definitions	
Term	Definition
BIM Execution Plan (BEP)	A document within which the proposed approach, capability, capacity and competencies of the prospective or selected Supplier sets out the response to the EIRs
CAD (Computer Aided Design) File	Electronic file produced using a CAD application (such as MicroStation or AutoCAD)
CDE (Common Data Environment)	The environment, which encapsulates the processes set out in SMP and BIM Execution Plan, for the production, use and management of Model File(s), Composite Model(s), Non-Graphical Data, Document Definition(s) and Document Rendition(s) as agreed between the Parties and set out in the MIDP(s)
Composite Model	Computer Aided Design (CAD) file(s) displaying one or more Model Files (attached as references), for the purpose of performing coordination activities and / or compiling Document Definitions
Documentation	A collection of Document Renditions
Document Definition	Data File produced, containing a view of the Non-Graphical Data and / or Model File(s) and / or Composite Model(s), to derive meaning for a specific purpose
Document Rendition	A data file in an immutable format, derived from a Document Definition
Handover Information	Model File(s), Composite Model(s), Non-Graphical Data, Document Definition(s) and Document Rendition(s) which have been agreed between the Parties to be produced, updated, maintained and delivered as set out in the MIDP(s) until the Defects Certificate has been issued
Information Artefacts	The collective term for Production Information, Handover Information and any other model or drawing deliverables identified in the within the MIDP and IMPDT – all Information Artefacts shall be authored, shared, published and archived within the CDE
MIDP (Master Information Delivery Plan)	A forward looking schedule of the Model File(s), Composite Model(s), Non-Graphical Data, Document Definition(s) and Document Rendition(s) which are to be produced, updated, maintained and delivered as Information Artefacts by the Supplier
Model File	Computer Aided Design (CAD) file(s) containing shape(s) with defined origin, orientation and dimensions, communicating the physical characteristics of the works. A Model File may also include Non-Graphical Data, associated to the CAD file(s) and / or shape(s), identifying the functional characteristics of the works
Non-Graphical Data	Data file containing alphanumeric characters, communicating the physical and functional characteristics of the works

Production Information	<p>The Model File(s), Composite Model(s), Non-Graphical Data, Document Definition(s) and Document Rendition(s) which have been agreed between the Parties to be produced, updated and maintained in order to provide the Works and be delivered, during the design and construction stages of the Project, as set out in the MIDP(s).</p> <p>Referred to within PAS1192-2 as the PIM (Project Information Model).</p>
Task Team	<p>Any team assembled to complete a task, which is typically discipline based (e.g. architectural task team, structural task team, bridge task team, track task team etc.)</p>

APPENDIX A: DOCUMENT MAP

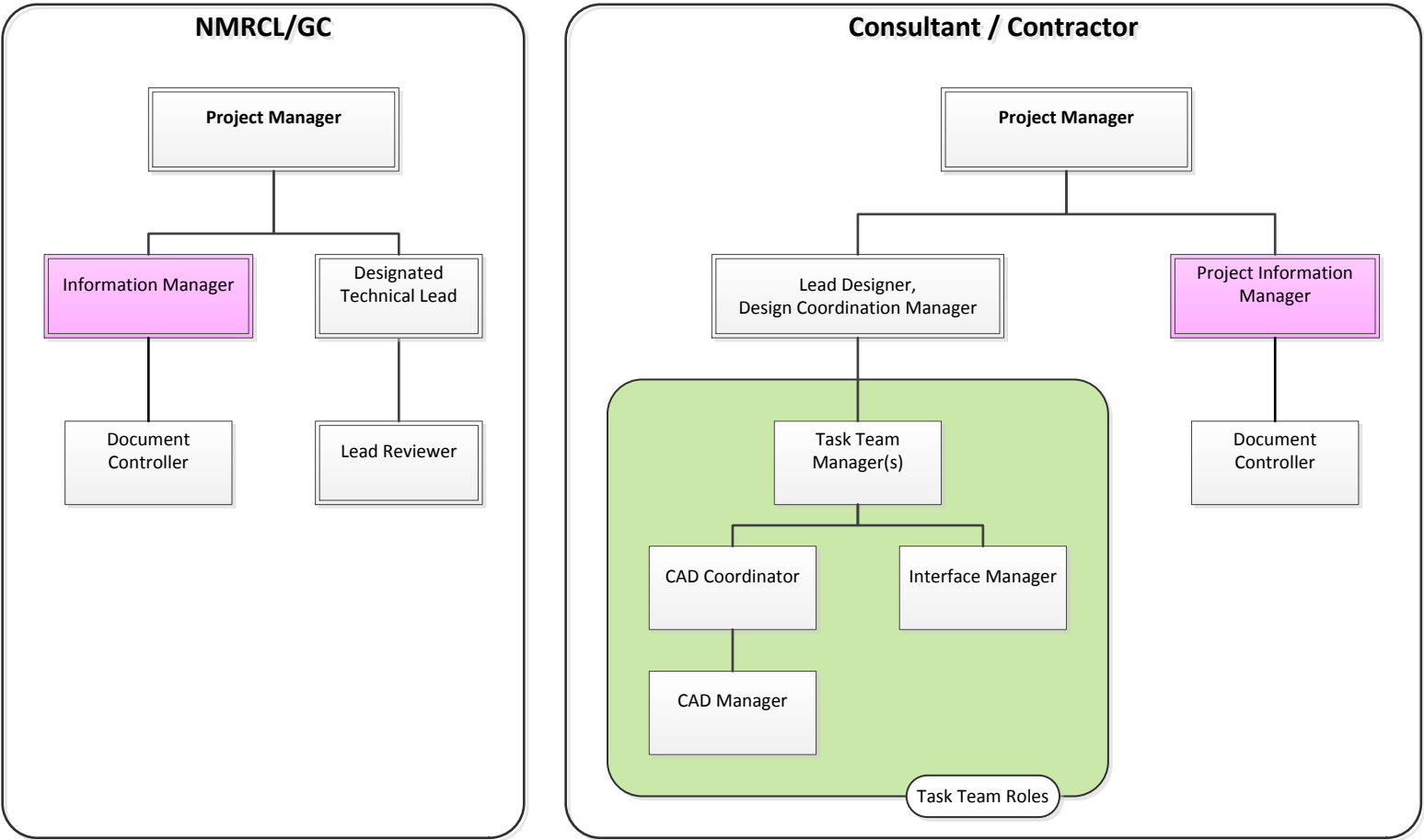


APPENDIX B: CDE (COMMON DATA ENVIRONMENT)

For the CDE End to End Process please refer to the following procedure:

- ***MMRCL Level 2 BIM E2E Workflow Process*** [Ref 10]

APPENDIX C: INFORMATION ROLES AND RESPONSIBILITIES



Notes:

The purpose of this diagram is only to illustrate the primary information management roles
Lines of authority may vary
An individual may undertake one or more roles

APPENDIX D: CDE – HIGH LEVEL WORKFLOW

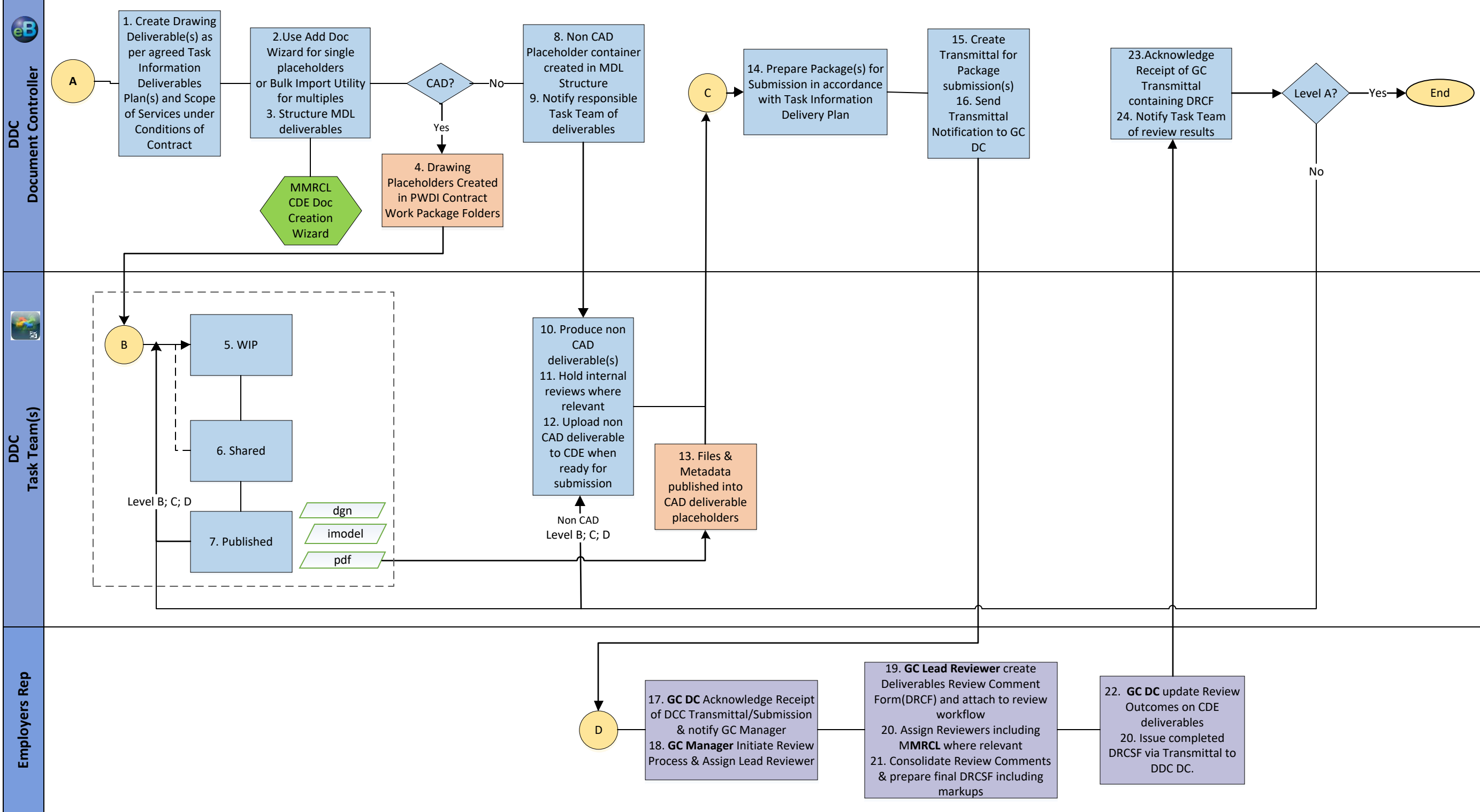
For the CDE High Level Workflows please refer to the following procedures:

- Drawing Information Artefacts: **MMRCL Level 3 Drawing Process** [Ref 11]
- Model Information Artefacts: **MMRCL Level 3 Model Process** [Ref 13]

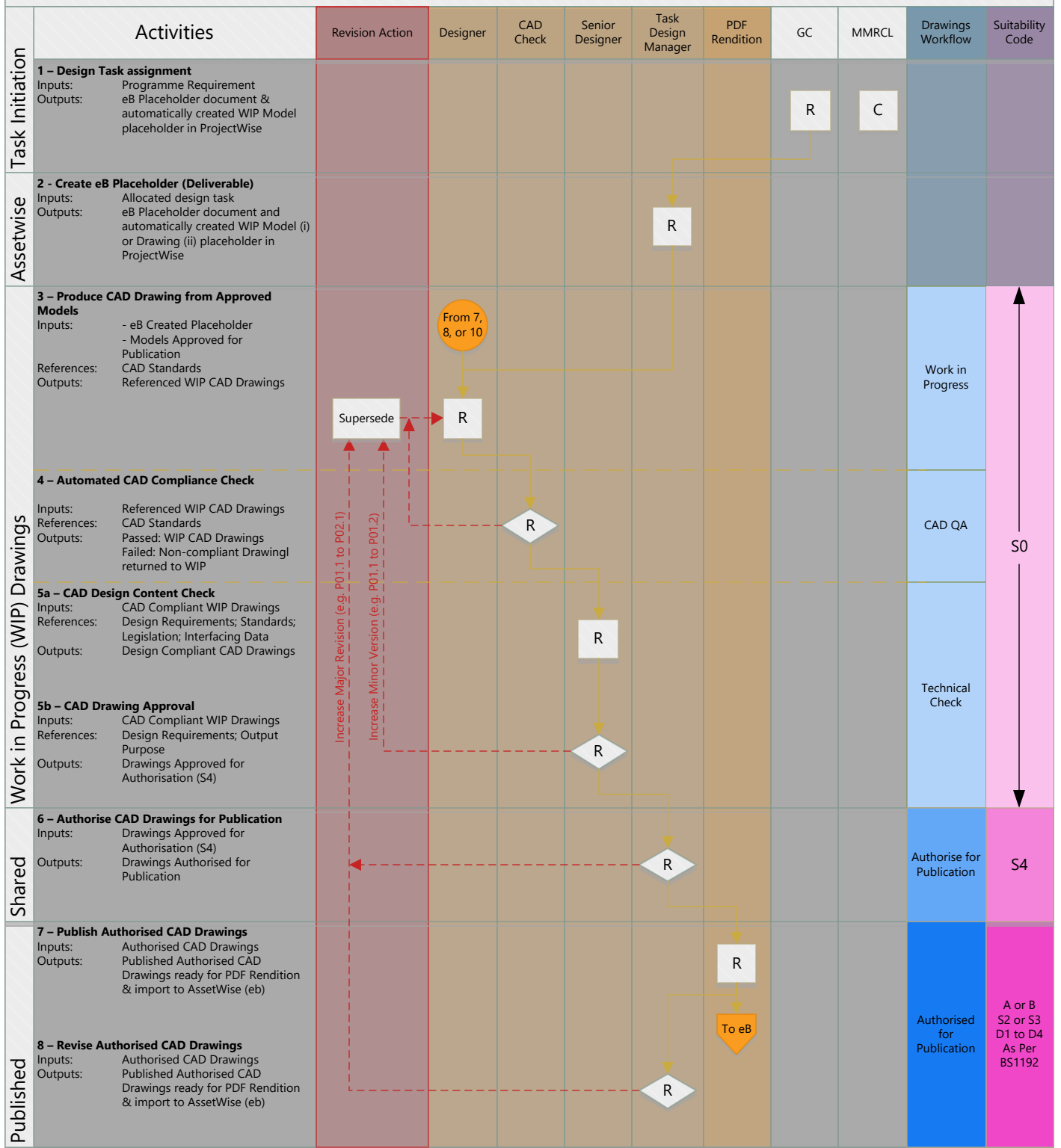
BIM CDE End to End Deliverables Workflow Process

Key/Legend	DDC Contractor	GC/MMRCL	CDE Custom	eB-PW Connector
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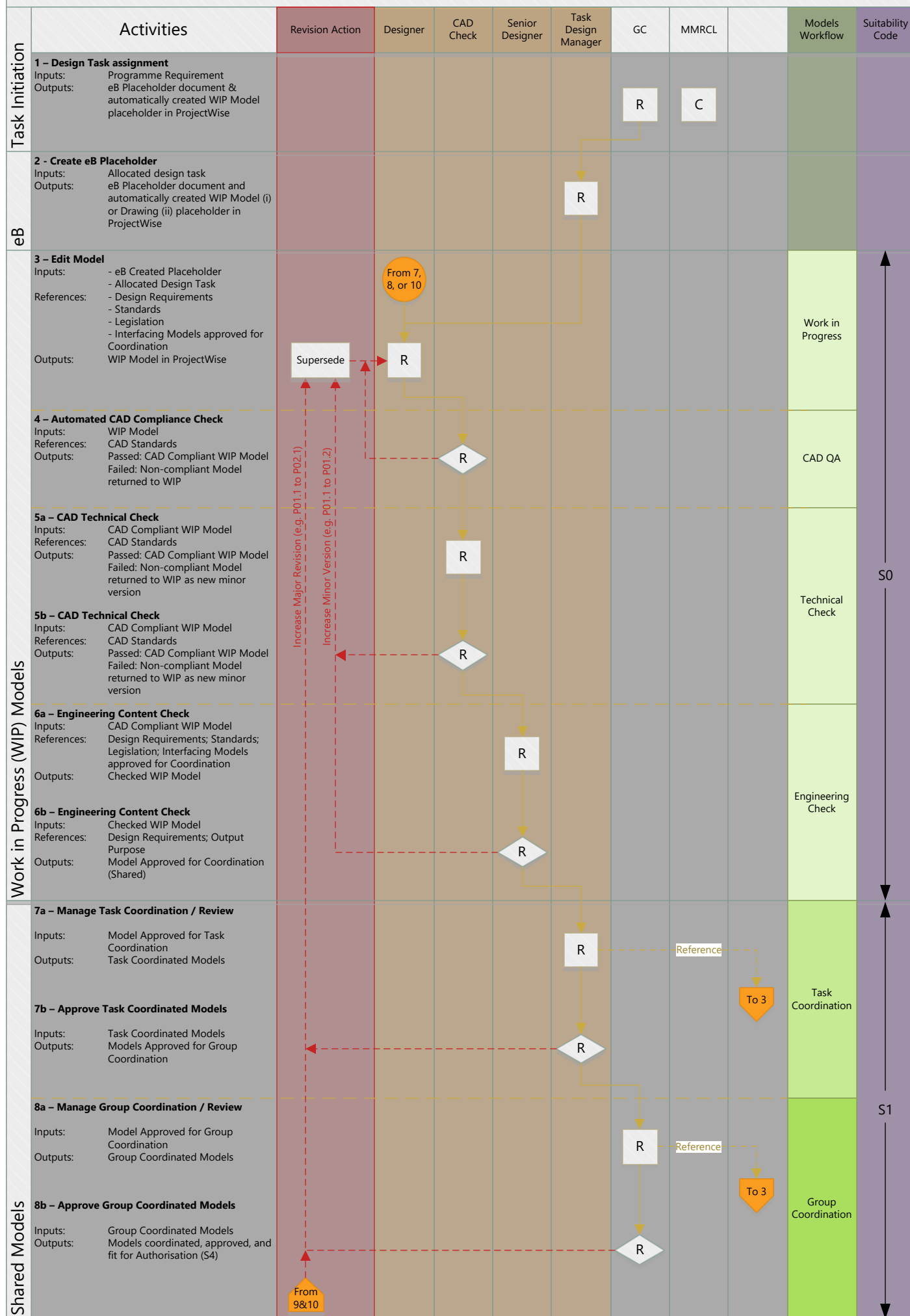
eB-PW Connector






Management of Drawing Data



Management of Model Data



Management of ProjectWise Model Data

	Activities	Revision Action	Designer	CAD Check	Senior Designer	Task Design Manager	GC	NMRCL		Models Workflow	Suitability Code
Shared	9 – Authorise CAD Drawings for Publication Inputs: Models Approved for Authorisation (S4) Outputs: Drawings Authorised for Publication									Authorise for Publication	S4
	10a – Publish Authorised CAD Drawings Inputs: Authorised CAD Drawings Outputs: Published Authorised CAD Drawings ready for PDF Rendition & import to AssetWise (eb)									Authorised for Publication	A or B S2 or S3 D1 to D4 As Per BS1192
Published	10b – Revise Authorised CAD Drawings Inputs: Authorised CAD Drawings Outputs: Published Authorised CAD Drawings ready for PDF Rendition & import to AssetWise (eb)					