



**CHENNAI METRO RAIL LIMITED
CHENNAI METRO RAIL PROJECT PHASE 2, CORRIDOR 4
TENDER No. C4-E&M-05**

ADDENDUM-1

“SUPPLY, INSTALLATION, TESTING, COMMISSIONING AND TRAINING OF ELECTRICAL, FIRE PROTECTION AND VAC WORKS FOR 18 ELEVATED STATIONS FROM POWERHOUSE STATION TO POONAMALLEE BYPASS STATION INCLUDING VIADUCT BETWEEN THE STATIONS (CH 10027.102 TO CH 25928.186), APPROACH RAMP, INCLUDING POONAMALLEE DEPOT FOR CORRIDOR 4 OF CHENNAI METRO RAIL PROJECT PHASE-II”.

**EMPLOYER: CHENNAI METRO RAIL LIMITED
COUNTRY: INDIA**



CHENNAI METRO RAIL LIMITED

CHENNAI METRO RAIL PROJECT PHASE 2, CORRIDOR 4

TENDER No. C4- E&M-05

TENDER DOCUMENTS

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SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No																																																						
1.	Part 1 Section II Bid Data Sheet ITB 9.1 Page 32 of 1752	A non-refundable Tender cost of INR. 40000/- (Rupees Forty Thousand Five Hundred only) or equivalent amount in USD shall be paid through a demand draft / NEFT/RTGS/SWIFT in the name of "Chennai Metro Rail Limited" payable at Chennai.	A non-refundable Tender cost of INR. 40000/- (<u>Rupees Forty Thousand only</u>) or equivalent amount in USD shall be paid through a demand draft / NEFT/RTGS/SWIFT in the name of "Chennai Metro Rail Limited" payable at Chennai.	Amended as Underlined SI. No 183																																																						
2.	Part 1 Section III Clause No. 1.1.1 Page 38 of 1752	<p>1.1.1 Personnel</p> <p>The Bidder must demonstrate that it has the personnel for the Key positions that meet the following requirements:</p> <table border="1"> <thead> <tr> <th>No.</th> <th>Position</th> <th>Minimum Educational Qualification</th> <th>No. of Key Personnel Positions.</th> <th>Total Work Experience (Minimum number of years)</th> <th>Experience in Similar Positions (Minimum number of years)</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Project Manager</td> <td>B.E/B.Tech in Electrical / Mechanical Eng.</td> <td>1</td> <td>20</td> <td>10</td> </tr> <tr> <td>2.</td> <td>Construction Managers</td> <td>B.E/B.Tech in Mechanical / Electrical and Electronics Eng.</td> <td>3</td> <td>15</td> <td>8</td> </tr> <tr> <td>3.</td> <td>Design Manager</td> <td>B.E/B.Tech in Electrical and Electronics Eng.</td> <td>1</td> <td>15</td> <td>8</td> </tr> <tr> <td>4.</td> <td>Chief Interface Coordinator</td> <td>B.E/B.Tech in Mechanical / Electrical and Electronics Eng.</td> <td>1</td> <td>15</td> <td>8</td> </tr> <tr> <td>5.</td> <td>Chief Quality Assurance & Control Manager</td> <td>B.E/B.Tech in Mechanical / Electrical and Electronics Eng.</td> <td>1</td> <td>15</td> <td>10</td> </tr> <tr> <td>6.</td> <td>Chief OHS&E Manager</td> <td>M. E/ M.Tech in Industrial Safety</td> <td>1</td> <td>15</td> <td>10</td> </tr> <tr> <td>7.</td> <td>BIM Manager</td> <td>B.E/B.Tech in Mechanical / Electrical and Electronics Eng.</td> <td>1</td> <td>10</td> <td>5</td> </tr> <tr> <td colspan="3">Total No. of Key Personnel</td> <td>9</td> <td></td> <td></td> </tr> </tbody> </table> <p>The Bidder shall provide details of the proposed personnel and their experience records in Forms PER-1 and PER-2 in Section IV, Bidding Forms.</p>	No.	Position	Minimum Educational Qualification	No. of Key Personnel Positions.	Total Work Experience (Minimum number of years)	Experience in Similar Positions (Minimum number of years)	1.	Project Manager	B.E/B.Tech in Electrical / Mechanical Eng.	1	20	10	2.	Construction Managers	B.E/B.Tech in Mechanical / Electrical and Electronics Eng.	3	15	8	3.	Design Manager	B.E/B.Tech in Electrical and Electronics Eng.	1	15	8	4.	Chief Interface Coordinator	B.E/B.Tech in Mechanical / Electrical and Electronics Eng.	1	15	8	5.	Chief Quality Assurance & Control Manager	B.E/B.Tech in Mechanical / Electrical and Electronics Eng.	1	15	10	6.	Chief OHS&E Manager	M. E/ M.Tech in Industrial Safety	1	15	10	7.	BIM Manager	B.E/B.Tech in Mechanical / Electrical and Electronics Eng.	1	10	5	Total No. of Key Personnel			9			<u>1.1.1 Personnel -Deleted</u>	Amended as Underlined SI. No 124
No.	Position	Minimum Educational Qualification	No. of Key Personnel Positions.	Total Work Experience (Minimum number of years)	Experience in Similar Positions (Minimum number of years)																																																					
1.	Project Manager	B.E/B.Tech in Electrical / Mechanical Eng.	1	20	10																																																					
2.	Construction Managers	B.E/B.Tech in Mechanical / Electrical and Electronics Eng.	3	15	8																																																					
3.	Design Manager	B.E/B.Tech in Electrical and Electronics Eng.	1	15	8																																																					
4.	Chief Interface Coordinator	B.E/B.Tech in Mechanical / Electrical and Electronics Eng.	1	15	8																																																					
5.	Chief Quality Assurance & Control Manager	B.E/B.Tech in Mechanical / Electrical and Electronics Eng.	1	15	10																																																					
6.	Chief OHS&E Manager	M. E/ M.Tech in Industrial Safety	1	15	10																																																					
7.	BIM Manager	B.E/B.Tech in Mechanical / Electrical and Electronics Eng.	1	10	5																																																					
Total No. of Key Personnel			9																																																							
3.	Part 1 Section IV A	5.8 Form PER-1: Proposed Personnel	5.8 Form PER-1: Proposed Personnel <u>Deleted</u>	Amended as Underlined																																																						

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
	Page 70 of 1752			
4.	Part 1 Section IV A Page 71 to 72 of 1752	5.9 Form PER-2: Resume of Proposed Personnel	5.9 Form PER-2: Resume of Proposed Personnel <u>Deleted</u>	Amended as Underlined
5.	Part 1 Section IV A Page 77 of 1752	5.14 Form MAN: Manufacturer's Authorization	5.14 Form MAN: Manufacturer's Authorization <u>Deleted</u>	Amended as Underlined Sl. No 127, 181
6.	Part 1 Section III EQC Clause No. 2.4.2(a) Specific Experience Page 45 of 1752	<p>Experience in construction in the role of Prime Contractor⁽ⁱ⁾ (single entity or JV member⁽ⁱⁱⁱ⁾) or sub-contractor must have been satisfactorily⁽ⁱⁱⁱ⁾ or substantially completed^(iv) during the last ten (10) years from the last day of the month prior to bid submission deadline.</p> <p>Supply, Installation, Testing and commissioning of Electrical, Fire Alarm & Detection, Fire Fighting System and Ventilation & Airconditioning and SCADA works involving a minimum number of</p> <p>1. One work of value INR 100 Crores or above :</p> <p style="text-align: center;">OR</p> <p>2. Two works of value INR 63 Crores or above</p>	<p>Experience in <u>Similar works</u>^(vii) in the role of Prime Contractor⁽ⁱ⁾ (single entity or JV member⁽ⁱⁱⁱ⁾) or sub-contractor must have been satisfactorily⁽ⁱⁱⁱ⁾ or substantially completed^(iv) during the last ten (10) years from the last day of the month prior to bid submission deadline involving a minimum number of:</p> <p>1. One work of value INR 100 Crores or above</p> <p style="text-align: center;">OR</p> <p>2. Two works <u>each</u> of value INR 63 Crores or above</p> <p style="text-align: center;">OR</p> <p>3. Three works <u>each</u> of value INR 50 Crores or above.</p>	Amended as underlined Sl. No 9, 22, 24

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		OR 3. Three works of value INR 50 Crores or above.		
7.	Part 1 Section III EQC Clause 2.4.2 (b) Page 46 of 1752	<p>For the works stated in 2.4.2 (a) above or other contracts completed and under implementation as prime contractor (single entity or JV Member) or subcontractor during the last ten (10) years from the last day of the month prior to bid submission deadline a minimum experience in the following key activities:</p> <p>Supply, Installation, Testing and commissioning of Electrical, Fire Alarm & Detection, Fire Fighting System and Ventilation & Airconditioning and SCADA works of At least three Elevated Metro stations / one Underground Metro Station.</p> <p>OR</p> <p>One Railway Workshop or Metro Depot.</p> <p>OR</p> <p>Execution of E&M (Electrical, HVAC, Fire protection and Integrated building management system) similar works of minimum 2000 KVA and above capacity for large multistorey building such as Airport, Hospital, Hotel, IT Park, commercial mall, any industrial project, factory etc.,</p>	<p>For the works stated in 2.4.2 (a) above or other contracts completed and under implementation as prime contractor (single entity or JV Member) or subcontractor during the last ten (10) years from the last day of the month prior to bid submission deadline a minimum experience in the following key activities:</p> <p>Supply, Installation, Testing and commissioning of <u>Similar works</u>^(vii) of At least three Elevated Metro stations / one Underground Metro Station.</p> <p>OR</p> <p>One Railway Workshop or Metro Depot.</p> <p>OR</p> <p><u>Large multistorey building such as Airport, Hospital, Hotel, IT Park, commercial mall, any industrial project, factory etc., with minimum transformer rating of 2000 KVA and above capacity.</u></p>	Amended as underlined Sl. No 24, 101,125, 126
8.	Part 1 Section III Page 47 of 1752		<p>New note added. Notes to be bidders: <u>(vii) Similar works for this contract shall be the work of "Supply, Installation, Testing and Commissioning of E&M works (which shall include any combination of Electrification</u></p>	Amended as underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
			<u>work with either all or any of these works, i.e., Fire detection system/ Fire suppression system/ BMS / SCADA / VAC works) of Metro Stations/ Mass Rapid Transit Systems/ Commercial Buildings/ Official Buildings/ Railway Stations/ Airports/ Hospital Buildings/ industrial Establishments". Such E&M work can as well be part of a larger contract.</u>	
9.	Part 1 Section IV A Bidding Forms 1.1 Page 51 of 1752	1.1 Letter of Technical Bid To, JGM(E&M) Chennai Metro Rail Limited, Poonamallee High Road, Koyembedu, Chennai- 600107, Tamil Nadu, India	1.1 Letter of Technical Bid To, <u>Director (Systems & Operations)</u> Chennai Metro Rail Limited, Poonamallee High Road, Koyembedu, Chennai- 600107, Tamil Nadu, India	Amended as Underlined.
10.	Part 1 Section IV A Bidding Forms 1.2 Page 51 of 1752	1.2 Letter of Price Bid To, JGM(E&M) Chennai Metro Rail Limited, Poonamallee High Road, Koyembedu, Chennai- 600107, Tamil Nadu, India	1.2 Letter of Price Bid To, <u>Director (Systems & Operations)</u> Chennai Metro Rail Limited, Poonamallee High Road, Koyembedu, Chennai- 600107, Tamil Nadu, India	Amended as Underlined.
11.	Part 1 Section IV A Bidding Forms 3.2.1		New clause added under Section 3.2.1 <u>3.2.1.1 Price Variation Formula for Cables (IEEMA):</u>	Added as Annexure- 1 Sl. No 178

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
	Page 57 of 1752			
12.	Part 1 Section IV A Bidding Forms Form 9 Page 95 of 1752	9. Undertaking for Minimum Local Content We hereby jointly and severally certify in accordance with clause '9.a' of the Order no. P-45021/2/2017-PP (BE-II) of Ministry of Commerce and Industry, Department of Promotion of Industry and Internal Trade (DPIIT) {formerly Department of Industrial Policy and Promotion (DIPP)}, Government of India dated 28.05.2018 that the item(s) offered meets the minimum local content of 80% (as specified in Section V).	9. Undertaking for Minimum Local Content <u>Deleted</u>	Amended as Underlined. Sl. No 128
13.	Part 1 Section IV A Form EXP 2 (Page 91 of 1752)	Form EXP-2: SPECIFIC EXPERIENCE	Form EXP-2 <u>(a)</u> : SPECIFIC EXPERIENCE	Amended as Underlined Sl. No 431
14.	Part 1 Section IV A Form EXP 2(b)		<u>New form (added)</u> <u>Form EXP-2 (b): EXPERIENCE IN KEY ACTIVITIES</u>	Added as Annexure 2 Sl. No 431
15.	Part 1 Section IV A Page 101 of 1752	1. Preamble	New Clause (added) 1. Preamble <u>i) Out of 3% towards Item A 2.6 (PMIS) of Price Centre A (Preliminaries), 1% will be back charged by CMRL and shall be debited from the Contractor's IPC towards implementation and maintenance of PMIS.</u>	Amended as Underlined Sl. No 129. 424

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
16.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 55,143, 232 & 326	MDB PANEL: i) Digital power quality meter for measurement of V, I, KW, KVA, KVAH, KWH, HZ, PF, THD etc., with SCADA monitoring through Modbus Ethernet.	MDB PANEL: i) Digital <u>Bidirectional</u> power quality meter for measurement of V, I, KW, KVA, KVAH, KWH, HZ, PF, THD etc., with BMS monitoring through Modbus Ethernet.	Amended as Underlined
17.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 59, 236	v) 4 Nos. dual ratio CTs 1000/630/5A, 15VA, CL-0.5 for hybrid power factor panel	v) 4 Nos. dual ratio CTs 1000/630/5A, 15VA, <u>CL-0.2s</u> for hybrid power factor panel	Amended as Underlined
18.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 81, 258	v) 4 Nos. dual ratio CTs 1000/400/5A, 15VA, CL-0.5 for hybrid power factor panel	v) 4 Nos. dual ratio CTs 1000/400/5A, 15VA, <u>CL-0.2s</u> for hybrid power factor panel	Amended as Underlined
19.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 147, 330	v) 4Nos. dual ratio CTs 630/200/5A, 15VA, CL-0.5 for hybrid power factor panel.	v) 4Nos. dual ratio CTs 630/ <u>400</u> /5A, 15VA, <u>CL-0.2s</u> for hybrid power factor panel.	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
20.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 169, 352	v) 4 Nos. dual ratio CTs 630/200/5A, 15VA, CL-0.5 for hybrid power factor panel	v) 4 Nos. dual ratio CTs 630/200/5A, 15VA, <u>CL-0.2s</u> for hybrid power factor panel	Amended as Underlined
21.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 566	B.1.9.1 - 2 Nos of HYBRID POWER FACTOR CORRECTION PANEL (100KVAR+100A) (IP 42) SVP	B.1.9.1 - 2 Nos of HYBRID POWER FACTOR CORRECTION PANEL (IP 42)	As Amended
22.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 573	B.1.9.2 - HYBRID POWER FACTOR CORRECTION PANEL (50KVAR+80A) (IP 42) - 2 No's per Station (17 STATIONS)	B.1.9.2 - HYBRID POWER FACTOR CORRECTION PANEL (IP 42) - 2 No's per Station	As Amended
23.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 578	B.1.9.2.1 - Active filter (Rate shall be quoted per Amps) Quantity – 2720 Amps	B.1.9.2.1 - Active filter (Rate shall be quoted per Amps) Quantity – <u>160 Amps</u>	Amended as Underlined
24.	Part 1 Section IV B Price	B.1.9.2.2 - Passive filter (Rate shall be quoted per KVAR) Quantity – 1700 KVAR	B.1.9.2.2 - Passive filter (Rate shall be quoted per KVAR) Quantity – <u>100 KVAR</u>	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
	Centre B (BOQ2) Sl. No 579			
25.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 580, 583, 585, 594, 595	<p>B.1.10 - Fire Pump Panels (FPP) (IP 54)</p> <p>A) INCOMER</p> <p>a)1no. 250A, 4P Automatic Transfer Switch and ATS must have monitoring of normal source, automatic changeover, test facility with Front panel display</p> <p>c) LED indication lamp for ON, OFF & TRIP, Phase Indication for R, Y and B, Tank 1&2 level indications with Lamp Test Push button</p> <p>C) OUTGOING</p> <p>a) 2 nos. 125A, 415V, Ics=25KA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button</p> <p>1 nos. 45kW, Soft starter comprising 3 Nos. TPN contactor AC-3 duty Auto/Manual switch, Start Stop push button, bimetallic over current relays single phasing preventer, Hour meter, ELR and timer & with potential free contacts</p>	<p>B.1.10 - Fire Pump Panels (FPP) (IP 55)</p> <p>A) INCOMER</p> <p>a)1no. 250A, 4P Automatic Transfer Switch and ATS must have monitoring of normal source, automatic changeover, test facility with Front panel display <u>and complete as per technical specifications.</u></p> <p>c) LED indication lamp for ON, OFF, TRIP, <u>&</u> Phase <u>indications</u> for R, Y and B, Tank 1 & 2 level indications with Lamp Test Push button.</p> <p>C) OUTGOING</p> <p>a) 2 nos. 125A, 415V, Ics=25KA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF, TRIP, <u>& Earth Fault</u> with Lamp test push button</p> <p>1 <u>Set of 45kW, Dual starters - soft starter & Star-Delta Starter (Bypass Starter)</u> comprising 3 Nos. TPN contactor AC-3 duty Auto/Manual switch, Start Stop push button, bimetallic over current relays single phasing preventer, Hour meter, ELR</p>	Amended as Underlined Sl. No 272, 368

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		for remote monitoring and control. Necessary control wiring from pressure switch and tank to panel.	<u>with CBCT and timer & with potential free contacts required / recommended by the Vendor GA drawing</u> for remote monitoring and control. Necessary control wiring from pressure switch and tank to panel.	
26.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 612, 614, 624,	<p>A) INCOMER</p> <p>a)1no. 160A, 4P Automatic Transfer Switch and ATS must have monitoring of normal source, automatic changeover, test facility with Front panel display</p> <p>c) LED indication lamp for ON, OFF & TRIP, Phase Indication for R, Y and B, Tank 1&2 level indications with Lamp Test Push button</p> <p>C) OUTGOING</p> <p>a) 1 nos. 125A, 415V, Ics=25KA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button</p> <p>1 nos. 45kW, Soft starter comprising 3 Nos. TPN contactor AC-3 duty Auto/Manual switch, Start Stop push button, bimetallic over current relays single phasing preventer, Hour meter, ELR and timer & with potential free contacts</p>	<p>A) INCOMER</p> <p>a)1no. 160A, 4P Automatic Transfer Switch and ATS must have monitoring of normal source, automatic changeover, test facility with Front panel display <u>and complete as per technical specifications.</u></p> <p>c) LED indication lamp for ON, OFF, TRIP & Phase <u>indications</u> for R, Y and B, Tank 1 & 2 level indications with Lamp Test Push button.</p> <p>C) OUTGOING</p> <p>a) 1 nos. 125A, 415V, Ics=25KA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF, TRIP & <u>Earth fault</u> with Lamp test push button</p> <p>1 nos. 45kW, <u>Dual starters - soft starter & Star-Delta Starter (Bypass Starter)</u> comprising 3 Nos. TPN contactor AC-3 duty Auto/Manual switch, Start Stop push button, bimetallic over current relays single phasing preventer, Hour meter, ELR <u>with CBCT and timer & with potential free contacts required / recommended by the Vendor GA drawing</u> for remote</p>	Amended as Underlined Sl. No 272, 368

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		for remote monitoring and control. Necessary control wiring from pressure switch and tank to panel.	monitoring and control. Necessary control wiring from pressure switch and tank to panel.	
27.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 822, 828, 833, 838, 843	<p>B.2.19.4 - SITC of 1 No. of 10inch Touch screen 4 button override keypad and accessories with the cover plate for the same</p> <p>B.2.19.6.4 - SITC of 1 No. of 4 button override keypad and accessories with the cover plate for the same</p> <p>B.2.19.7.4 - SITC of 1 No. of 4 button override keypad and accessories with the cover plate for the same</p> <p>B.2.19.8.4 - SITC of 1 No. of 4 button override keypad and accessories with the cover plate for the same</p> <p>B.2.19.9.4 - SITC of 1 No. of 4 button override keypad and accessories with the cover plate for the same</p>	<p>B.2.19.4 - SITC of 1 No. of 10inch Touch screen <u>6</u> button override keypad and accessories with the cover plate for the same</p> <p>B.2.19.6.4 - SITC of 1 No. of <u>6</u> button override keypad and accessories with the cover plate for the same</p> <p>B.2.19.7.4 - SITC of 1 No. of <u>6</u> button override keypad and accessories with the cover plate for the same</p> <p>B.2.19.8.4 - SITC of 1 No. of <u>6</u> button override keypad and accessories with the cover plate for the same</p> <p>B.2.19.9.4 - SITC of 1 No. of <u>6</u> button override keypad and accessories with the cover plate for the same</p>	Amended as Underlined
28.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 874	B.3.3 - Supply, Installation and Terminations conforming to specifications for XLPE insulated, FRLSH (as specified in Schedule B.3.1) and Fire Survival (as specified in Schedule B.3.2) armoured cables of sizes given below including the cost of supplying, fixing and crimping Al/Cu lugs, double compression Flame proof brass glands,shrouds, insulation tape etc. This also includes making holes in gland plate complete as per specifications and as required.	B.3.3 - Supply, Installation and Terminations conforming to specifications for XLPE insulated, FRLSH (as specified in Schedule B.3.1) and Fire Survival (as specified in Schedule B.3.2) armoured cables of sizes given below including the cost of supplying, fixing and crimping <u>electro-tinned copper / Aluminium /bimetallic lugs</u> , double compression <u>Flame proof/Weatherproof</u> brass glands, shrouds, insulation tape etc. This also includes making holes in gland plate complete as per specifications and as required.	Amended as Underlined Sl. No 134, 135, 406
29.	Part 1 Section IV	B.3.5 - Cable Trays & Raceways	B.3.5 - Cable Trays & Raceways	Amended as

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
	B Price Centre B (BOQ2) Sl. No 896	Supply, fabrication & installation of perforated return flanged type cable trays with factory fabricated horizontal & vertical bends, reducers, tee's, cross overs and other accessories as required conforming to IEC-61537. The tray shall be hot dipped galvanized for corrosion protection conforming to DIN 267 Part 10, EN 10346, BS EN ISO 1461, GI return flanged cable trays with 2 mm thick GI sheets conforming to E & M Specifications . The trays shall be tested for minimum safe working load and the deflection should be within the limits as per standard. All accessories including GI angles, threaded rods, fastners, clamps etc shall be provided (or installed on wall supported on suitable brackets as required) complete as per specifications, as required and as below.	Supply, fabrication & installation of perforated return flanged type cable trays with factory fabricated horizontal & vertical bends, reducers, tee's, cross overs and other accessories as required conforming to IEC-61537. The tray shall be hot dipped galvanized for corrosion protection conforming to <u>IS 2629</u> , DIN 267 Part 10, EN 10346, BS EN ISO 1461, GI return flanged cable trays with 2 mm thick GI sheets conforming to <u>Technical Specifications and IS Codes</u> . The trays shall be tested for minimum safe working load and the deflection should be within the limits as per standard. All accessories including GI angles, threaded rods, <u>fasteners</u> , clamps etc shall be provided (or installed on wall supported on suitable brackets as required) complete as per specifications, as required and as below.	Underlined
30.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 905	B.3.6 - Supply & installation of cable ladder type tray with factory prefabricated horizontal & vertical bends, reducers, tee's, cross overs and other accessories as required conforming to IEC-61537. The cable ladder shall be hot dipped galvanized for corrosion protection confirming to DIN 267 Part 10, EN 10346, BS EN ISO 1461, GI return flanged cable trays with 2 mm thick GI sheets conforming to E & M Specifications. The cable ladder shall be tested for minimum safe working load & the deflection should be within the limits as per standard. The rung size shall be of 30x15x2mm suitable for fixing the cable clamps & the space between the rungs shall be maximum 300 mm, as required. All accessories including GI angles, threaded rods, fastners, clamps etc shall be provided (or installed	B.3.6 - Supply & installation of cable ladder type tray with factory prefabricated horizontal & vertical bends, reducers, tee's, cross <u>overs</u> , and other accessories as required conforming to IEC-61537. The cable ladder shall be hot dipped galvanized for corrosion protection confirming to <u>IS 2629</u> , DIN 267 Part 10, EN 10346, BS EN ISO 1461, GI return flanged cable trays with 2 mm thick GI sheets conforming to <u>Technical Specifications and IS Code</u> . The cable ladder shall be tested for minimum safe working load & the deflection should be within the limits as per standard. The rung size shall be of 30x15x2mm suitable for fixing the cable clamps & the space between the rungs shall be maximum 300 mm, as required. All accessories including GI angles, threaded rods, <u>fasteners</u> , clamps etc shall be provided (or	Amended as Underlined

Sl No.	Clause No. ITB/GCC/SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		on wall supported on suitable brackets as required) complete as per specifications, as required and as below.	installed on wall supported on suitable brackets as required) complete as per specifications, as required and as below.	
31.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 909	B.3.7 - Supply, installation and testing of sheet steel two-compartment raceways in floor, fabricated from 1.5 mm thick GI with minimum coating thickness 275 gm / sq. meter on both sides with removable cover plate complete with counter sunk cadmium /steel-plated brass screws, bends, tee-junctions, cross junctions, etc. rendered electrically continuous as approved and of following sizes:	B.3.7 - Supply, installation and testing of sheet steel two-compartment raceways in floor, fabricated from 1.5 mm thick GI with minimum coating thickness on both sides <u>as per technical specifications and IS Codes.</u> with removable cover plate complete with counter sunk cadmium /steel-plated brass screws, bends, tee-junctions, cross junctions, etc. rendered electrically continuous as approved and of following sizes:	Amended as Underlined
32.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 913	Supply, installation and testing of sheet steel compartment raceways in surface/suspendent, fabricated from 1.5 mm thick GI with minimum coating thickness 275 gm / sq. meter on both sides with removable cover plate complete with counter sunk cadmium /steel-plated brass screws, bends, support rods, tee-junctions, cross junctions, etc. rendered electrically continuous as approved and of following sizes:	<u>B.3.8</u> - Supply, installation and testing of sheet steel compartment raceways in surface/ <u>suspended</u> , fabricated from 1.5 mm thick GI with minimum coating thickness <u>as per technical specifications and IS Codes</u> with removable cover plate complete with counter sunk cadmium /steel-plated brass screws, bends, support rods, tee-junctions, cross junctions, etc. rendered electrically continuous as approved and of following sizes:	Amended as Underlined
33.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No. No 923, 926, 929, 932, 939	B.4.1, B.4.2, B.4.3, B.4.4, B.4.5 (excluding the cost of Conduit, switches, sockets & switch boxes)	B.4.1, B.4.2, B.4.3, B.4.4, B.4.5 (<u>E</u> xcluding the cost of Conduit, switches, <u>MCB</u> sockets & switch boxes)	Amended as Underlined Sl. No 15

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
34.	Centre B (BOQ2) Sl. No. No 937, 938,	<p>a) In case of 10 nos. light fixtures looped together and controlled directly from one no. MCB in DB, quantity to be paid shall be 1 No. as per Item No. B.4.1.1 & B.4.2.1 as applicable and quantity to be paid shall be 9 Nos. as per item no. B.4.1.2 & B.4.2.2 as applicable. The cost of switches, sockets & switch boxes in the rate in no. B.4.8.</p> <p>b) In case of 5 nos. light fixtures looped together and controlled from switch located in a room, quantity to be paid shall be 1 no. as per Item No. B.4.1.1& B.4.2.1 and quantity to be paid for 4 Nos. as per item no. B.4.1.2 & B.4.2.2. Conduit & wire laid from MCB in DB to first light point via switch point shall not be paid separately and is included in the rate in item no.B.4.1 & B.4.2. The cost of switches, sockets & switch boxes in the rate in no. B.4.8.</p>	<p>a) In case of 10 nos. light fixtures looped together and controlled directly from one no. MCB in DB, quantity to be paid shall be 1 No. as per Item No. B.4.1.1 & B.4.2.1 as applicable and quantity to be paid shall be 9 Nos. as per item no. B.4.1.2 & B.4.2.2 as applicable. The cost of switches, sockets & switch boxes in the rate in no. <u>B.4.9.</u></p> <p>b) In case of 5 nos. light fixtures looped together and controlled from switch located in a room, quantity to be paid shall be 1 no. as per Item No. B.4.1.1& B.4.2.1 and quantity to be paid for 4 Nos. as per item no. B.4.1.2 & B.4.2.2. Conduit & wire laid from MCB in DB to first light point via switch point shall not be paid separately and is included in the rate in item no.B.4.1 & B.4.2. The cost of switches, sockets & switch boxes in the rate in no. <u>B.4.9.</u></p>	Amended as Underlined
35.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No. No 975	B.5.1.7 - Supply Installation Testing & Commissioning of surface/suspended 22SWG CRCA sheet White epoxy polyester powder Coated housing emergency Light . Total lumen output minimum 200 lumens, power consumption 4.7Watts, Over charge protection and deep charge protection for battery, 16-24 hours charging time, 3 hours backup time for battery, CCT 4000 to 5700K, CRI>80 with SDCM<5 with IP-20, IK08 protection, P.F>0.95, surge protection of 4kV, THD <10%, 3.6V/2Ah NimH Battery, Red indication for charging the light as indicated on	B.5.1.7 - Supply Installation Testing & Commissioning of surface/suspended emergency Light. Total lumen output minimum <u>660 lumens</u> , power consumption <u>6Watts</u> , over charge protection and deep charge protection for battery, 16-24 hours charging time, 3 hours backup time for battery, CCT 4000 to 5700K, CRI>80 with SDCM<5 with IP-20, IK08 protection, P.F>0.95, surge protection of 4kV, THD <10%, 3.6V/2Ah NimH Battery, Red indication for charging the light as indicated on luminaire. The life class of the luminaire should be 50000 burning hours at L70 and luminaire as per	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		luminaire. The life class of the luminaire should be 50000 burning hours at L70 and luminaire as per technical specification. Area applicable: concourse and platform entrances.	technical specification. Area applicable: concourse and platform entrances	
36.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No. No 999	B.6.3 - Supply, laying, termination, Testing and commissioning of PVC insulated, FRLSH, Copper Cables for Earthing in green colour, as per IS 7098 and Specifications, for interconnecting the earth station with METs of the following sizes in trenches/surface/wall/ground complete with accessories as per specifications & drawing as required. B.6.3.1 - 1Cx150 Sq. mm, Cu Cable B.6.3.2 - 1Cx95 Sq. mm, Cu Cable B.6.3.3 - 1Cx70 Sq. mm, Cu Cable B.6.3.4 - 1Cx35 Sq. mm, Cu Cable	B.6.3 - Supply, laying, termination, Testing and commissioning of <u>XLPE insulated, PVC Sheathed, FRLSH, Flexible (Unarmoured) Copper Cables</u> for Earthing in green colour, as per IS 7098 and Specifications, for interconnecting the earth station with METs of the following sizes in trenches/surface/wall/ground complete with accessories as per specifications & drawing as required. B.6.3.1 - 1Cx150 Sq. mm, Cu Cable B.6.3.2 - 1Cx95 Sq. mm, Cu Cable B.6.3.3 - 1Cx70 Sq. mm, Cu Cable B.6.3.4 - 1Cx35 Sq. mm, Cu Cable	Amended as Underlined Sl..No 13, 373, 374

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing			As Amended			Remarks/ Pre-Bid Query SI. No
37.	Part 1 Section IV B Price Centre B (BOQ2) SI. No 1027 to 1030	B.7.1 - Supply & installation of the following items Horizontal Mesh for lightning Protection			B.7.1 - Supply & installation of the following items Horizontal Mesh for lightning Protection <u>consists of below</u>	13950.00	Metre	Amended as Underlined
		B.7.1.1 - Roof Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm ² , of Material- SS 304 & TESTED as per Standard EN 62561-2.	13950.00	Metre	B.7.1.1 - Roof Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm ² , of Material- SS 304 & TESTED as per Standard EN 62561-2.			
		B.7.1.2 - Conductor holder for Brick of Material- Weathered proof Polyamide/Stainless Steel, Material thickness- 2.5 mm, is capable of holding Rod 8 mm & Complied as per Standard IEC 62305.			B.7.1.2 - Conductor holder for Brick of Material- Weathered proof Polyamide/Stainless Steel, Material thickness- 2.5 mm, is capable of holding Rod 8 mm & Complied as per Standard IEC 62305.			
		B.7.1.3 - Universal connector of Material- Stainless Steel, with clamping range- 8-10mm, with truss head screw M10x35 mm & Complied as per Standard EN 62561-1.			B.7.1.3 - Universal connector of Material- Stainless Steel, with clamping range- 8-10mm, with truss head screw M10x35 mm & Complied as per Standard EN 62561-1.			

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing			As Amended			Remarks/ Pre-Bid Query SI. No	
38.	Part 1 Section IV B Price Centre B (BOQ2) SI. No 1031 to 1035	B.7.2 - Supply & installation of the following items Air Termination for lightning Protection			B.7.2 - Supply & installation of the following items Air Termination for lightning Protection consists of below	144.00	Set	Amended as Underlined	
		Air-termination rod having length- 1000 mm of Material- Cu of Diameter Ø 16 mm, & Complied as per Standard EN 62561-2			Air-termination rod having length- 1000 mm of Material- Cu of Diameter Ø 16 mm, & Complied as per Standard EN 62561-2				
		Side Wall Clamp for 1 mtr., air terminal			Side Wall Clamp for 1 mtr., air terminal				
		B.7.2.1 - Air-termination rod clamps for connecting air-termination rods with one or two conductors. Material of clamp SS 304 , with clamping range of air-termination rod 16 mm and Clamping range of conductor Rod 2x 8 mm, & Complied as per Standard EN 62561-1.	144.00	Set	B.7.2.1 - Air-termination rod clamps for connecting air-termination rods with one or two conductors. Material of clamp SS 304 , with clamping range of air-termination rod 16 mm and Clamping range of conductor Rod 2x 8 mm, & Complied as per Standard EN 62561-1.				
		B.7.2.2 - Fixing Clamp for air terminal connecting two conductors in parallel manner. Material- Stainless Steel, with clamping range- Rod / Rod 8 mm & Complied as per Standard IEC 62305			B.7.2.2 - Fixing Clamp for air terminal connecting two conductors in parallel manner. Material- Stainless Steel, with clamping range- Rod / Rod 8 mm & Complied as per Standard IEC 62305				

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No																								
39.	Part 1 Section IV B Price Centre B (BOQ2) SI. No 1038 to 1041	<table border="1"> <tr> <td>B.7.3.2 - Down Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm², of Material- SS 304 & Complied as per Standard EN 62561-2 consists of below</td> <td>72.00</td> <td>Set</td> </tr> <tr> <td>B.7.3.3 - Conductor holder for Brick of Material- Stainless Steel/Weather proof (Polyamide), Material thickness- 2.5 mm, is capable of holding Rd 8 mm & Complied as per Standard IEC 62305 With accessories self-threaded screw and washers, Material SS (M10x25mm)</td> <td></td> <td></td> </tr> <tr> <td>B.7.3.4 - Test Joint (Folding Clamp) with intermediate plate for round and flat conductor of Material- Stainless Steel, Material thickness- 2.5 mm, with clamping range- Rd / FI 8-10 / 30 mm, & Complied as per Standard EN 62561-1.</td> <td></td> <td></td> </tr> <tr> <td>B.7.3.5 - Providing of flat conductor holder as per Standard IEC 62305. Installed with 2 hexagonal bolts.</td> <td></td> <td></td> </tr> </table>	B.7.3.2 - Down Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm ² , of Material- SS 304 & Complied as per Standard EN 62561-2 consists of below	72.00	Set	B.7.3.3 - Conductor holder for Brick of Material- Stainless Steel/Weather proof (Polyamide), Material thickness- 2.5 mm, is capable of holding Rd 8 mm & Complied as per Standard IEC 62305 With accessories self-threaded screw and washers, Material SS (M10x25mm)			B.7.3.4 - Test Joint (Folding Clamp) with intermediate plate for round and flat conductor of Material- Stainless Steel, Material thickness- 2.5 mm, with clamping range- Rd / FI 8-10 / 30 mm, & Complied as per Standard EN 62561-1.			B.7.3.5 - Providing of flat conductor holder as per Standard IEC 62305. Installed with 2 hexagonal bolts.			<table border="1"> <tr> <td>B.7.3.2 - Down Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm², of Material- SS 304 & Complied as per Standard EN 62561-2 consists of below</td> <td>72.00</td> <td>Set</td> </tr> <tr> <td>B.7.3.2.1 - Conductor holder for Brick of Material- Stainless Steel/Weather proof (Polyamide), Material thickness- 2.5 mm, is capable of holding Rd 8 mm & Complied as per Standard IEC 62305 With accessories self-threaded screw and washers, Material SS (M10x25mm)</td> <td></td> <td></td> </tr> <tr> <td>B.7.3.2.2 - Test Joint (Folding Clamp) with intermediate plate for round and flat conductor of Material- Stainless Steel, Material thickness- 2.5 mm, with clamping range- Rd / FI 8-10 / 30 mm, & Complied as per Standard EN 62561-1.</td> <td></td> <td></td> </tr> <tr> <td>B.7.3.2.3 - Providing of flat conductor holder as per Standard IEC 62305. Installed with 2 hexagonal bolts.</td> <td></td> <td></td> </tr> </table>	B.7.3.2 - Down Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm ² , of Material- SS 304 & Complied as per Standard EN 62561-2 consists of below	72.00	Set	B.7.3.2.1 - Conductor holder for Brick of Material- Stainless Steel/Weather proof (Polyamide), Material thickness- 2.5 mm, is capable of holding Rd 8 mm & Complied as per Standard IEC 62305 With accessories self-threaded screw and washers, Material SS (M10x25mm)			B.7.3.2.2 - Test Joint (Folding Clamp) with intermediate plate for round and flat conductor of Material- Stainless Steel, Material thickness- 2.5 mm, with clamping range- Rd / FI 8-10 / 30 mm, & Complied as per Standard EN 62561-1.			B.7.3.2.3 - Providing of flat conductor holder as per Standard IEC 62305. Installed with 2 hexagonal bolts.			Amended as Underlined
B.7.3.2 - Down Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm ² , of Material- SS 304 & Complied as per Standard EN 62561-2 consists of below	72.00	Set																										
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B.7.3.2.2 - Test Joint (Folding Clamp) with intermediate plate for round and flat conductor of Material- Stainless Steel, Material thickness- 2.5 mm, with clamping range- Rd / FI 8-10 / 30 mm, & Complied as per Standard EN 62561-1.																												
B.7.3.2.3 - Providing of flat conductor holder as per Standard IEC 62305. Installed with 2 hexagonal bolts.																												
40.	Part 1 Section IV B Price Centre B (BOQ2) SI. No 1044	B.8.1 - Design, manufacture, testing at works, supplying, testing of sheet steel structure of following rating (Amps) of Fire rated Sandwich type TPN "Cu" bus duct having neutral cross section equal to phase, 50% Internal earth bus and Class F insulation and enclosure will be of minimum 1.6 mm GI sheet steel/2.5mm AL sheet epoxy powder coated. The bus bar will be of copper with radialised edges. Individual sections will not be more than 3 meters long uniblock. One section will be connected to adjacent section by joint system operating by single bolt. Sub assembly shall be removable without disturbing the adjacent bus bars. Rates shall be inclusive of all	B.8.1 - Design, manufacture, testing at works, supplying, testing of sheet steel structure of following rating (Amps) of Fire rated Sandwich type TPN "Cu" bus duct having neutral cross section equal to phase, 50% Internal earth bus and Class F insulation and enclosure will be of minimum 1.6 mm GI sheet steel/2.5mm AL sheet epoxy powder coated. The bus bar will be of copper with radialised edges. Individual sections will not be more than 3 meters long uniblock. One section will be connected to adjacent section by joint system operating by single bolt. Sub assembly shall be removable without disturbing the adjacent bus bars. Rates shall be inclusive of all accessories i.e. bends, wall flanges, end feed	Amended as Underlined																								

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		accessories i.e. bends, wall flanges , end feed box, etc. as required.	box, <u>2 Runs of 50mm x 6mm Copper flat along the length of the bus duct</u> etc. as required.	
41.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 1049 to 1051	B.9.1 - Supply of 2 x 30 KVA True Online Double Conversion, Modular type, Parallel Redundant, 3 Phase AC Input & 3 Phase AC Output, UPS System having an Ingress protection Rating of IP 20 (as per E & M Specifications) consisting of the following: UPS Paralleling kit for switchover to redundant unit in case of failure of either UPS. K 13, copper Galvanic Isolation Transformer at Incoming supply side of UPS.	B.9.1 - Supply of 2 x 30 KVA True Online Double Conversion, Parallel Redundant, 3 Phase AC Input & 3 Phase AC Output, UPS System having an Ingress protection Rating of IP 20 (as per <u>Technical</u> Specifications) consisting of the following: UPS Paralleling kit for switchover to redundant unit in case of failure of either UPS. K 13, copper Galvanic Isolation Transformer for <u>each UPS</u> .	Amended as Underlined
42.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 1059 to 1061	B.9.2 - Supply of 2 x 40 KVA True Online Double Conversion, Modular type, Parallel Redundant, 3 Phase AC Input & 3 Phase AC Output, UPS System having an Ingress protection Rating of IP 20 (as per E & M Specifications) consisting of the following: UPS Paralleling kit for switchover to redundant unit in case of failure of either UPS. K 13, copper Galvanic Isolation Transformer at Incoming supply side of UPS.	B.9.2 - Supply of 2 x 40 KVA True Online Double Conversion, Parallel Redundant, 3 Phase AC Input & 3 Phase AC Output, UPS System having an Ingress protection Rating of IP 20 (as per <u>Technical</u> Specifications) consisting of the following: UPS Paralleling kit for switchover to redundant unit in case of failure of either UPS. K 13, copper Galvanic Isolation Transformer for <u>each UPS</u> .	Amended as Underlined
43.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 1069 to 1071	B.9.3 - Supply of 2 x 50 KVA True Online Double Conversion, Modular type, Parallel Redundant, 3 Phase AC Input & 3 Phase AC Output, UPS System having an Ingress protection Rating of IP 20 (as per E & M Specifications) consisting of the following: UPS Paralleling kit for switchover to redundant unit in case of failure of either UPS. K 13, copper Galvanic Isolation Transformer at Incoming supply side of UPS.	B.9.3 - Supply of 2 x 50 KVA True Online Double Conversion, Parallel Redundant, 3 Phase AC Input & 3 Phase AC Output, UPS System having an Ingress protection Rating of IP 20 (as per <u>Technical</u> Specifications) consisting of the following: UPS Paralleling kit for switchover to redundant unit in case of failure of either UPS. K 13, copper Galvanic Isolation Transformer for <u>each UPS</u> .	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
44.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 1079 to 1089	B-10.1- Pipes B-10.2 - Supply,fixing and laying of GI pipes complete with joints and other accessories and supports as required B-10.3 - Supply and laying of following HDPE pipe under paved areas/track crossings including necessary excavation & back filling complete as required. The unit of measurement (UOM) - "No".	B-10.1- Pipes B-10.2 - Supply, fixing and laying of GI pipes complete with joints and other accessories and supports as required B-10.3 - Supply and laying of following HDPE pipe under paved areas/track crossings including necessary excavation & back filling complete as required. The unit of measurement (UOM) - "Meters".	Amended as Underlined Sl. No 170
45.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 1090		New item added <u>B11 - Supply, installation, Testing and commissioning of bus cable 2R x 2C x 0.5 Sq.mm EIB twisted pair cable to connect all Keypad and all LCPs.: Quantity - 6480 meters</u>	Amended as Underlined
46.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 1091		New item added <u>B.12 - Design, Supply, Installation Testing & Commissioning of each AHF Panel to achieve unity P.F and THDI / THD V less than 5%. It shall comply to IEEE 519-2014. The PQ Solution should have an incomer of suitable breaker rating as per SLD and shall be rated for suitable current rating, 415V, +/- 10 % 50Hz, 3 phase, 50KA, 3 Phase, 4 Wire System. IP rating shall be IP42. The active compensation shall be 3 level Topology 12-IGBT based certified by UL. It should filter harmonics from 2nd to 51st individual harmonic order and shall be selectable for the entire range. CT position could be Load side or Grid side and the CT secondary could be either 1A or 5A. It should communicate to BMS/SCADA through HMI. The Panel must be duly housed in epoxy powder coated</u>	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
			<p><u>2mm thick CRCA sheet steel semi compartmentalised enclosure free standing type with all supports, accessories, switch gears, control gears, protections, wiring, interconnections, control MCBs.</u></p> <p><u>Insulated bus bar pan assembly made from Cu and rated and rated for suitable current rating. The short circuit withstand capacity shall be 50KA / 1 Sec (Icw) for the main bus bar and the rated impulse withstand voltage shall be 6 KV.</u></p> <p><u>AHF panel shall do harmonic mitigation, power factor correction, imbalance, and neutral compensation. Active Filter, Standards compliance/certification as per Specification. The AHF Panel, should also have an energy server which would collect, store, and provides web access and visualization to various energy parameters and enable remote supervision.</u></p> <p><u>Quantity – 5580 Amps</u></p>	
47.	Part 1 Section IV B Price Centre B (BOQ2) Sl. No 1092		<p>New item added</p> <p><u>B.13 - Supply, Installation, testing and commissioning of IP-65(IK-10) polycarbonate, anticorrosive, fire retardant & self-extinguishing cable junction boxes with terminals of the sizes cable termination suitable for minimum 150 Sq.mm cable, surface mounting, with all accessories as required complete in all respects.</u></p> <p><u>Quantity – 18 Nos</u></p>	Amended as underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
48.	Part 1 Section IV B Price Centre C (BOQ 3) Sl. No.21	C.1.2 Supply, installation, testing & commissioning of diesel Engine driven common stand by pump, horizontal centrifugal end suction pumping set with CI body, bronze impeller, SS Shaft / CS shaft and sleeve and gland packing and connected by means of a flexible coupling to a water cooled diesel engine capable to deliver 2280 LPM (137 m ³ / Hr) / 2850 LPM (171 m ³ / Hr) . The pump shall be coupled to suitable HP of Diesel engine radiator water cooled type with speed of 1500 / 2900 RPM and complete set shall be mounted on common base frame. 12V,180AH Batteries & battery leads with stand, Fuel tank with stand & gauge glass, Fuel tank shall be of 4mm thick sheet,Fuel piping with valves. The quoted rate shall includes coupling gaurd, and other stanadard accessories, RCC foundation (as recommended by manufacturere) and foundation bolts, etc. Rate shall also include Exhaust pipe of required length and size to discharge exhaust gases externally, with muffler, day oil tank of 387 ltrs capacity with first charge and hand pump set,complete and the capacity of the day tank should be 5-8 Hrs of the SFC with support structure anchoring arrangement, with all controls and valves.	C.1.2 Supply, installation, testing & commissioning of diesel Engine driven common stand by pump, horizontal centrifugal end suction pumping set with CI body, bronze <u>impeller</u> , SS Shaft / CS shaft and sleeve and gland packing and connected by means of a flexible coupling to a <u>water-cooled</u> diesel engine capable to deliver 2280 LPM (137 m ³ / Hr) / 2850 LPM (171 m ³ / Hr). The pump shall be coupled to suitable HP of Diesel engine radiator water cooled type and complete set shall be mounted on common base frame. 12V,180AH Batteries & battery leads with stand, Fuel tank with stand & gauge glass, Fuel tank shall be of 4mm thick sheet, Fuel piping with valves. The quoted rate shall <u>include</u> coupling <u>guard</u> , and other <u>standard</u> accessories, RCC foundation (<u>will be done by Civil contractor</u>) and foundation bolts, etc. Rate shall also include Exhaust pipe of required length and size to discharge exhaust gases externally, with muffler, day oil tank <u>minimum of 250 litres</u> capacity with first charge and hand pump set, complete and the capacity of the day tank should be 5-8 Hrs of the SFC with support structure anchoring arrangement, with all controls and valves.	Amended as underlined. Sl. No 65, 141, 312
49.	Part 1 Section IV B Price Centre C	C.3.2 Supply, Installation, Testing and Commissioning of UL listed / FM approved Gate Valves with rising stem (OS & Y) with grooved end of the following sizes as per	C.3.2 Supply, Installation, Testing and Commissioning of UL listed / FM approved Gate Valves with rising stem (OS & Y) with grooved end of the following sizes as per Specifications.	Amended as underlined. Sl. No 253

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	(BOQ 3) Sl. No 80	Specifications. and Pressure rating of Gate valves Rising Type: max working pressure 300 psi(21 bar)	and Pressure rating of Gate valves Rising Type: max working pressure <u>of 16 Bar.</u>	
50.	Part 1 Section IV B Price Centre C (BOQ 3) Sl. No 98	C.3.5 Supply, Installation, Testing and Commissioning of UL listed / FM approved Duct iron 'Y' type Strainers with grooved ends of the following sizes with nuts, bolts, gaskets etc. complete in all respect as described in Specifications.	C.3.5 Supply, Installation, Testing and Commissioning of UL listed <u>Ductile</u> iron 'Y' type Strainers with grooved ends of the following sizes with nuts, bolts, gaskets etc. complete in all respect as described in Specifications.	As Amended
51.	Part 1 Section IV B Price Centre C (BOQ 3) Sl. No 114	C.3.11 Supply and installation of UL listed / FM approved stainless steel Expansion Bellow, suitable for PN 16 requirements as per Specifications.	C.3.11 Supply and installation of stainless-steel Expansion Bellow, suitable for PN 16 requirements as per Specifications.	As Amended Sl. No 257
52.	Part 1 Section IV B Price Centre C (BOQ 3) Sl. No 139	C.4.2 - Providing and fixing 63 mm diameter, 15 metre long, reinforced rubber lined hose (RRL - pipe conforming to IS 636/88 type-B with Stainless steel (SS 316 - male and female Instantaneous type coupling, wire complete as per IS: 636.	C.4.2 - Providing and fixing 63 mm diameter, 15 meter long, reinforced rubber lined hose (RRL - pipe conforming to IS 636/88 <u>type-A</u> with Stainless steel (SS 316 - male and female Instantaneous type coupling, wire complete as per IS: 636.	Amended as underlined. Sl. No 259
53.	Part 1 Section IV B Price Centre C (BOQ 3) Sl. No 166	C.5.5 - Supply, Installation, Testing and Commissioning of UL listed, SS 304 Flexbile Hose with Inlet and Outlet fitting, with nominal pressure of 16 bar. The inlet fitting shall be 25mm dia size, whereas outlet fitting shall be 15mm dia as per specification with necessary supports.	C.5.5 - Supply, Installation, Testing and Commissioning of UL listed, SS 304 <u>Flexible</u> Hose (<u>Braided type</u>) with Inlet and Outlet fitting, with nominal pressure of 16 bar. The inlet fitting shall be 25mm dia size, whereas outlet fitting shall be 15mm dia as per specification with necessary supports.	Amended as underlined. Sl. No 315

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing		As Amended		Remarks/ Pre-Bid Query Sl. No
54.	Part 1 Section IV B Price Centre C (BOQ 3) Sl. No 212, 213, 214	G.7.1- 150 Kg Cylinder with Novec 1230 and Accessories	18 Nos	<u>C.7.1- 140 L Cylinder Capacity with minimum filling of 112kg Novec 1230 clean agent and Accessories</u>	<u>29</u> Nos	Amended as underlined. Sl. No. 142, 264
		G.7.2 - 120 Kg Cylinder with Novec 1230 and Accessories	54 Nos	<u>C.7.2 – 120 L Cylinder Capacity with minimum filling of 96kg Novec 1230 clean agent and Accessories</u>	<u>31</u> Nos	
		G.7.3 - 80 Kg Cylinder with Novec 1230 and Accessories	36 Nos	<u>C.7.3 – 80 L Cylinder Capacity with minimum filling of 65kg Novec 1230 clean agent and Accessories</u>	<u>34</u> Nos	
55.	Part 1 Section IV B Price Centre C (BOQ 3) Sl. No 215, 219, 226 to 238	G.7.4 - Master Cylinder Accessories	108 Set	<u>C.7.4 - Master Cylinder Accessories</u>	<u>54</u> Set	Amended as underlined. Sl. No 265
		G.7.5 - End Slave Cylinder Accessories	108 Set	<u>C.7.5 - End Slave Cylinder Accessories</u>	<u>40</u> Set	
		G.7.6.1 - Manifold Check Valve 2"	48 Nos	<u>C.7.6.1 - Manifold Check Valve 2"</u>	<u>80</u> Nos	
		G.7.6.2 - Discharge Nozzles	48 Nos	<u>C.7.6.2 - Discharge Nozzles</u>	<u>108</u> Nos	
		G.7.6.3 - Discharge Pressure Switch	48 Nos	<u>C.7.6.3 - Discharge Pressure Switch</u>	<u>54</u> Nos	
		G.7.6.4 - Seamless (Carbon Steel) Piping for Fire suppression Cylinder with all fittings like, manifolds, flanges, bends,	18 Lot	<u>C.7.6.4 - Seamless (Carbon Steel) Piping for Fire suppression Cylinder with all fittings like, manifolds, flanges, bends,</u>	<u>54</u> Lots	

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing		As Amended		Remarks/ Pre-Bid Query SI. No
		tees, elbows, reducers, GI clamps, GI hangers etc. with painting		tees, elbows, reducers, GI clamps, GI hangers etc. with painting		
		G.7.5.5 - Conventional 4 Zone Gas Release panel with Battery Backup and seamless connectivity with Main FACP	18 Nos	<u>C.7.6.5</u> - Conventional 4 Zone Gas Release panel with Battery Backup and seamless <u>connectivity</u> with Main FACP	<u>54</u> Nos	
		G.7.6.6 - Conventional Photo Electric Smoke Detector with base - System Sensor	48 Nos	<u>C.7.6.6</u> - Conventional Photo Electric Smoke Detector with base - System Sensor	<u>108</u> Nos	
		G.7.6.7 - Conventional Heat Detector - System Sensor	48 Nos	<u>C.7.6.7</u> - Conventional Heat Detector - System Sensor	<u>108</u> Nos	
		G.7.6.8 - Response indicator	18 Nos	<u>C.7.6.8</u> - Response indicator	<u>54</u> Nos	
		G.7.6.9 - Gas Release Switch	18 Nos	<u>C.7.6.9</u> - Gas Release Switch	<u>54</u> Nos	
		G.7.6.10 - Abort Switch	18 Nos	<u>C.7.6.10</u> - Abort Switch	<u>54</u> Nos	
		G.7.6.11 - Horn Strobe for Indoor Application-High volume - UL Listed	18 Nos	<u>C.7.6.11</u> - Horn Strobe for Indoor Application-High volume - UL Listed	<u>54</u> Nos	
		G.7.6.12 - Fire Alarm Bell for Indoor Application	18 Nos	<u>C.7.6.12</u> - Fire Alarm Bell for Indoor Application	<u>54</u> Nos	
		G.7.6.13 - Gas discharge warning sign LED panel	18 Nos	<u>C.7.6.13</u> - Gas discharge warning sign LED panel	<u>54</u> Nos	

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
56.	Part 1 Section IV B Price Centre D (BOQ4) Sl. No 26	D.4 - SS 304 Secondary drain pan with insulation for IDU as per Technical specifications-1500X1350	D.4 - SS 304 Secondary drain pan with insulation for IDU as per technical specifications.	As Amended
57.	Part 1 Section IV B Price Centre D (BOQ4) Sl. No 28	Supply, Installation, Testing and Commissioning of Interconnecting refrigerant pipe work (Hard drawn copper tubes shall be used. Soft copper tubes shall be used up to 12.7 mm diameter) with closed cell elastomeric nitrile rubber tubular insulation wrapped with treated woven glass cloth between each set of indoor & outdoor units as per specification. Refrigerant gas line tubes shall insulate with 25 mm thickness nitrile rubber for the size up to 15.9 mm outer diameter, 32 mm thickness nitrile rubber for the size above 15.9 mm outer diameter copper tubes and 13 mm thickness nitrile rubber for liquid line copper tubes. All piping shall be properly laid in covered perforated Cable tray & supported with Galvanised steel hanger as per specification and typical installation drawings. (Copper tubes shall comply with ASTM B 280-16).	Supply, Installation, Testing and Commissioning of Interconnecting refrigerant pipe work (Hard drawn copper tubes shall be used. Soft copper tubes shall be used up to 12.7 mm diameter) with closed cell elastomeric nitrile rubber tubular insulation wrapped with treated woven glass cloth between each set of indoor & outdoor units as per specification. Refrigerant gas line tubes shall insulate with 25 mm thickness nitrile rubber for the size up to 15.9 mm outer diameter, 32 mm thickness nitrile rubber for the size above 15.9 mm outer diameter copper tubes and 13 mm thickness nitrile rubber for liquid line copper tubes. (Copper tubes shall comply with ASTM B 280-16).	As Amended
58.	Part 1 Section IV B Price Centre D (BOQ4) Sl. No 81	D.8.1 - Supply, installation, testing and commissioning of 2 core / 3 core 1.5 sqmm cross section shielded Signal/Communication cable as recommended by OEM conforming IEC/IS standard, installed in perforated cable tray with GI conduits between indoor and Outdoor units.	D.8.1 - Supply, installation, testing and commissioning of 2 core / 3 core 1.5 sqmm cross section shielded Signal/Communication cable as recommended by OEM conforming IEC/IS standard, between indoor and Outdoor units.	As Amended Sl. No 235

Sl No.	Clause No. ITB/GCC/SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
59.	Part 1 Section IV B Price Centre D (BOQ5 - E.1.1) Sl. No 6	f. Amplifier card	<u>f. Deleted</u>	Amended as underlined. Sl. No 342
60.	Part 1 Section IV B Price Centre D (BOQ5 - E.14) Sl. No 43	E.14 - Supply, Laying, Testing and commissioning at the site of work of Fiber optical armoured single mode Cables (Refer technical specification Part 2 - SECTION VI C) Quantity – 4500 Nos	E.14 - Supply, Laying, Testing and commissioning at the site of work of <u>Fibre</u> optical armoured single mode Cables (Refer technical specification Part 2 - SECTION VI C) Quantity – 4500 <u>Mtrs</u>	Amended as Underlined
61.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 53, 135	MDB PANEL: i) Digital power quality meter for measurement of V,I,KW,KVA,KVAH, KWH, HZ, PF,THD etc., with SCADA monitoring through Modbus Ethernet.	MDB PANEL: i) Digital <u>Bidirectional</u> power quality meter for measurement of V, I, KW, KVA, KVAH, KWH, HZ, PF, THD etc., with SCADA monitoring through Modbus Ethernet.	Amended as Underlined
62.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 57, 139	v) 4 Nos. dual ratio CTs 3200/630/5A, 15VA, CL-0.5 for hybrid power factor panel.	v) 4 Nos. dual ratio CTs 3200/ <u>1600</u> /5A, 15VA, <u>CL-0.2s</u> for hybrid power factor panel.	Amended as Underlined

Sl No.	Clause No. ITB/GCC/SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
63.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 79, 161	v) 4 Nos. dual ratio CTs 1600/1000/5A, 15VA, CL-0.5 for hybrid power factor panel.	v) 4 Nos. dual ratio CTs 1600/1000/5A, 15VA, <u>CL-0.2s</u> for hybrid power factor panel.	Amended as Underlined
64.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 259	a) 1No. 400A, 415V, Ics=25KA, 4P MCCB's with Microprocessor releases with LCD display Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays)& LED indication lamp for ON, OFF & TRIP with Mechanical padlock and Lamp test push button	a) 1No. <u>100A</u> , 415V, Ics=25KA, 4P MCCB's with Microprocessor releases with LCD display Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) & LED indication lamp for ON, OFF & TRIP with Mechanical padlock and Lamp test push button	Amended as Underlined
65.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 261, 262	c) 3 nos. 200A, 415V, Ics=25KA, TPN MCCB's with Microprocessor releases with LCD display Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) & LED indication lamp for ON, OFF & TRIP with Lamp test push button d) 2 nos. 125A, 415V, Ics=25KA, TPN MCCB's with Microprocessor releases with LCD display Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) & LED indication lamp for ON, OFF & TRIP with Lamp test push button	c) 3 nos. 200A, 415V, Ics=25KA, <u>4P</u> MCCB's with Microprocessor releases with LCD display Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) & LED indication lamp for ON, OFF & TRIP with Lamp test push button d)2 nos. 125A, 415V, Ics=25KA, <u>4P</u> MCCB's with Microprocessor releases with LCD display Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) & LED indication lamp for ON, OFF & TRIP with Lamp test push button	Amended as Underlined
66.	Part 1 Section IV B Price	a) 2 Nos.250A, 415V, 25kA, 4P Motorised MCCBs (with Electrical & Mechanical interlock)with SCADA connectivity, 240V AC shunt trip coil and having Microprocessor releases with LCD display Protection	a) 2 Nos.250A, 415V, <u>16kA</u> , 4P Motorised MCCBs (with Electrical & Mechanical interlock) with SCADA connectivity, 240V AC shunt trip coil and having Microprocessor releases with LCD display Protection against Overload (with base	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
	Centre F (BOQ6) Sl. No 266	against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays), Clear indication of type of fault when tripped etc., NO / NC contacts for interlocks and indications and Status Indication ON, OFF, TRIP and also necessary accessories.	setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays), Clear indication of type of fault when tripped etc., NO / NC contacts for interlocks and indications and Status Indication ON, OFF, TRIP and also necessary accessories.	
67.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 299	a) 2 Nos.200A, 415V, 25kA, 4P Motorised MCCBs (with Electrical & Mechanical interlock)with SCADA connectivity, 240V AC shunt trip coil and having Microprocessor releases with LCD display Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays), Clear indication of type of fault when tripped etc., NO / NC contacts for interlocks and indications and Status Indication ON, OFF, TRIP and also necessary accessories.	a) 2 Nos.200A, 415V, <u>16kA</u> , 4P Motorised MCCBs (with Electrical & Mechanical interlock) with SCADA connectivity, 240V AC shunt trip coil and having Microprocessor releases with LCD display Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays), Clear indication of type of fault when tripped etc., NO / NC contacts for interlocks and indications and Status Indication ON, OFF, TRIP and also necessary accessories.	Amended as Underlined
68.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 355	125A 415V, 36kA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button	125A 415V, 36kA, <u>4P</u> MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button	Amended as Underlined
69.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 413	b) LED indication lamp for ON, OFF & TRIP, Lamp test Push button	b) LED indication lamp for ON, OFF & TRIP, Lamp test Push button <u>and 1 No Digital KWH Meter with 3 Nos CL-1 CT</u>	Amended as Underlined Sl. No 452

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
70.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 417	a) 400A 415V, 36kA, 4P MCCB with 240V AC shunt trip coil and having microprocessor release with LCD display (1)SCADA monitoring and control capability (2)Provision for measurement of three phase current(3) Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) + Instantaneous (4) Clear indication of type of fault when tripped etc.(5) NO / NC contacts for interlocks and indications (6) Status Indication ON, OFF, TRIP.Lamp test Push button	a) 400A 415V, 36kA, 4P MCCB with 240V AC shunt trip coil and having microprocessor release with LCD display (1)SCADA monitoring and control capability (2)Provision for measurement of three phase current(3) Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) + Instantaneous (4) Clear indication of type of fault when tripped etc.(5) NO / NC contacts for interlocks and indications (6) Status Indication ON, OFF, TRIP. Lamp test Push button <u>and 1 No Digital KWH Meter with 3 Nos CL-1 CT.</u>	Amended as Underlined Sl. No 452
71.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 419	a) 200A 415V, 36kA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button.	a) 200A 415V, 36kA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button <u>and 1 No Digital KWH Meter with 3 Nos CL-1 CT.</u>	Amended as Underlined Sl. No 452
72.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 469, 470	F.1.13 - AC & VENTILATION PANEL (WORK SHED) (IP 54) a) 11 nos. 63A, 415V, Ics=25KA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button b)4 nos. 32A, 415V, Ics=25KA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit	F.1.13 - AC & VENTILATION PANEL (WORK SHED) (IP 54) a) <u>12 nos.</u> 63A, 415V, Ics=25KA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button b) <u>6 nos.</u> 32A, 415V, Ics=25KA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button	Amended as Underlined

Sl No.	Clause No. ITB/GCC/SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button		
73.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 487	a) 200A 415V, 36kA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button	a) 200A 415V, <u>25kA</u> , TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button	Amended as Underlined Sl. No 456
74.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 489	a) 160A 415V, 36kA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button	a) 160A 415V, <u>25kA</u> , TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button	Amended as Underlined Sl. No 456
75.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 491	a) 400A 415V, 36kA, 4P MCCB with 240V AC shunt trip coil and having microprocessor release with LCD display (1)SCADA monitoring and control capability (2)Provision for measurement of three phase current(3) Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) + Instantaneous (4) Clear indication of type of fault when tripped etc.(5) NO / NC contacts for interlocks and indications	a) 400A 415V, <u>25kA</u> , 4P MCCB with 240V AC shunt trip coil and having microprocessor release with LCD display (1) SCADA monitoring and control capability (2) Provision for measurement of three phase current(3) Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) + Instantaneous (4) Clear indication of type of fault when tripped etc.(5) NO / NC contacts for interlocks and indications	Amended as Underlined Sl. No 456
76.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 497	a) 63A 415V, 36kA,TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button	a) 63A 415V, <u>25kA</u> , TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button	Amended as Underlined Sl. No 456

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
77.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 499	a) 32A 415V, 36kA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button	a) 32A 415V, <u>25kA</u> , TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button	Amended as Underlined Sl. No 456
78.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 502, 507	a) 1 Nos.160A, 415V, 16kA, 4P MCCB with SCADA connectivity, 240V AC shunt trip coil and having Microprocessor releases with LCD display Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays), Surge protection device (SPD) Type-II with inbuilt fuse suitable to withstand required short circuit current, Clear indication of type of fault when tripped etc., NO / NC contacts for interlocks and indications and Status Indication ON, OFF, TRIP and also necessary accessories. b) LED indication lamp for ON, OFF & TRIP, Phase Indication for R, Y and B with Lamp Test Push button c) Metering i) 1 No Digital Voltmeter. ii) 1 No Digital Ammeter iii) 1 No Digital MFM.	a) <u>2 Nos.</u> 160A, 415V, 16kA, 4P MCCB with SCADA connectivity, 240V AC shunt trip coil and having Microprocessor releases with LCD display Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays), Surge protection device (SPD) Type-II with inbuilt fuse suitable to withstand required short circuit current, Clear indication of type of fault when tripped etc., NO / NC contacts for interlocks and indications and Status Indication ON, OFF, TRIP and also necessary accessories. b) LED indication lamp for ON, OFF & TRIP, Phase Indication for R, Y and B with Lamp Test Push button c) Metering i) 1 No Digital Voltmeter. ii) 1 No Digital Ammeter iii) <u>1 No Bi- Directional Digital kWh Meter with Amps rating & MODBUS communication</u>	Amended as Underlined 457
79.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 514	F.1.16 - Water Pump Panel (WPP) (IP 54)	F.1.16 - Water Pump Panel (WPP) (<u>IP 55</u>)	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
80.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 554 to 557, 561, 566, 570 to 572, 583	<p>F.1.19 - Fire Pump Panels (FPP) (IP 65)</p> <p>A) INCOMER</p> <p>a) 2 No's of 630 A, 415V, 36kA, 4 Pole, Electrically operated Draw Out type ACB (with Electrical & Mechanical interlock), complete with safety shutters, 240V AC shunt trip coil & closing coil and having microprocessor based releases with LCD display Provision for measurement of V, A, W, VAR, VA, Wh, VARh, Hz, power factor etc, Protection against Overload, Short circuit and earth fault (all with adjustable time delays), Measurement of interrupted currents, differentiated fault indications, maintenance indicators ,Last five trippings and event histories and time stamping with facility for consulting the history file, maintenance indicator register etc ,Communication module to remotely read and set parameters for the protection functions,inbuilt Ethernet provisions for communication, transmission of all the calculated indicators and measurements, Signaling of the cause of tripping and alarms, NO/NC contacts for interlocks and indications and also necessary accesories.</p> <p>b)1no. 630A, 4P Automatic Transfer Switch and ATS must have monitoring of normal source, automatic changeover, test facility with front panel LCD display</p>	<p>F.1.19 - Fire Pump Panels (FPP) (IP 55)</p> <p>A) INCOMER</p> <p>a) 2 No's of 630 A, 415V, <u>25kA</u> 4 Pole, Electrically operated Draw Out type ACB (with Electrical & Mechanical interlock), complete with safety shutters, 240V AC shunt trip coil & closing coil and having microprocessor based releases with LCD display Provision for measurement of V, A, W, VAR, VA, Wh, VARh, Hz, power factor etc, Protection against Overload, Short circuit and earth fault (all with adjustable time delays), Measurement of <u>interrupted</u> currents, <u>differentiated</u> fault indications, maintenance indicators ,Last five <u>tripping's</u> and event histories and time stamping with facility for consulting the history file, maintenance indicator register etc ,Communication module to remotely read and set parameters for the protection functions, inbuilt Ethernet provisions for communication, transmission of all the calculated indicators and measurements, <u>Signalling</u> of the cause of tripping and alarms, NO/NC contacts for interlocks and indications and also necessary <u>accessories</u>.</p> <p>b)1no. 630A, 4P Automatic Transfer Switch and ATS must have monitoring of normal source, automatic changeover, test facility with front panel LCD display and <u>complete as per technical specifications</u>.</p> <p>LED indication lamp for ON, OFF, TRIP & Phase <u>indications</u> for R, Y and B, Tank 1 & 2 level indications with Lamp Test Push button.</p>	Amended as Underlined Sl. No 271, 450, 451

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No
		<p>LED indication lamp for ON, OFF & TRIP, Phase Indication for R, Y and B, Tank 1&2 level indications with Lamp Test Push button</p> <p>iv) 3 Nos. CTs, 250/5A, 10VA, CL-1 for metering.</p> <p>C) OUTGOING</p> <p>a) 2 nos. 400A, 415V, Ics=25KA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button</p> <p>1 nos. 117kW, Soft starter comprising 3 Nos. TPN contactor AC-3 duty Auto/Manual switch, Start Stop push button, bimetallic over current relays single phasing preventer, ELR and timer & with potential free contacts for remote monitoring and control. Necessary control wiring from pressure switch and tank to panel.</p> <p>c) 1 nos. 32A, 230V, Ics=25KA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button</p>	<p>iv) 3 Nos. CTs, <u>630/5A</u>, 10VA, CL-1 for metering.</p> <p>C) OUTGOING</p> <p>a) 2 nos. 400A, 415V, Ics=25KA, TPN MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF, TRIP & <u>Earth Fault</u> with Lamp test push button</p> <p>1 <u>Set of 117kW, Dual starters - soft starter & Star-Delta Starter (Bypass Starter)</u> comprising 3 Nos. TPN contactor AC-3 duty Auto/Manual switch, Start Stop push button, bimetallic over current relays single phasing preventer, Hour meter, ELR <u>with CBCT</u> and timer & with potential free contacts <u>required / recommended by the Vendor GA drawing</u> for remote monitoring and control. Necessary control wiring from pressure switch and tank to panel.</p> <p>c) 1 nos. 32A, 230V, Ics=25KA, <u>DP</u> MCCB's with fixed neutral and with variable overcurrent and short circuit releases & LED indication lamp for ON, OFF & TRIP with Lamp test push button</p>	

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
81.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 587, 588, 589	<p>F.1.20 - HYBRID POWER FACTOR CORRECTION PANEL (250KVAR+300A) (IP 42) - 2 No's per Depot Design, Supply, Installation Testing & Commissioning of each Hybrid Panel to achieve 0.98 Lag and THDI / THD V less than 5%. It shall comply to IEEE 519-2014 . The PQ Solution should have an incomer of 1000A ACB and shall be rated for 1000 Amps, 415V, +/- 10 % 50Hz, 3 phase, 36KA , 3 Phase, 4 Wire System. IP rating shall be IP42 .The active compensation shall be 3 level Topology 12-IGBT based certified by UL. It should filter harmonics from 2nd to 50th individual harmonic order and shall be selectable for the entire range. CT position could be Load side or Grid side and the CT secondary could be either 1A or 5A. It shall have Auto disconnection feature beyond ambient 45 Deg.C. Response time shall be 50 micro Sec. Switching device for passive compensation shall be Contactor. The PF controller shall be microprocessor based. It shall be type tested design as per IS 16636-2017, IEC 61921 and IEC 61439-1 & 2. It should communciate to SCADA through HMI.</p> <p>The capacitor units shall be rated at 525 V. The circuit should be tuned such that the series resonant frequency should be below the lowest harmonic order expected to be present in the electrical network and the detuned reactor shall be of 14%. The Panel must be duly housed in epoxy powder coated 2mm thick CRCA sheet steel semi compartmentalised enclosure free standing type with all supports, accessories, switch gears, control gears, protections, wiring, interconnections, control MCBs.The</p>	<p>F.1.20 - HYBRID POWER FACTOR CORRECTION PANEL (IP 42) - 2 No's per Depot Design, Supply, Installation Testing & Commissioning of each Hybrid Panel to achieve 0.98 Lag and THDI / THD V less than 5%. It shall comply to IEEE 519-2014. The PQ Solution should have an incomer of 1000A ACB and shall be rated for 1000 Amps, 415V, +/- 10 % 50Hz, 3 phase, <u>50KA</u> , 3 Phase, 4 Wire System. IP rating shall be IP42 .The active compensation shall be 3 level Topology 12-IGBT based certified by UL. It should filter harmonics from 2nd to 50th individual harmonic order and shall be selectable for the entire range. CT position could be Load side or Grid side and the CT secondary could be either 1A or 5A. It shall have Auto disconnection feature beyond ambient 45 Deg.C. Response time shall be 50 <u>micro-sec</u>. Switching device for passive compensation shall be Contactor. The PF controller shall be microprocessor based. It shall be type tested design as per IS 16636-2017, IEC 61921 and IEC 61439-1 & 2. It should <u>communicate</u> to SCADA through HMI.</p> <p>The capacitor units shall be rated at 525 V. The circuit should be tuned such that the series resonant frequency should be below the lowest harmonic order expected to be present in the electrical network and the detuned reactor shall be of 14%. The Panel must be duly housed in epoxy powder coated 2mm thick CRCA sheet steel semi compartmentalised enclosure free standing type with all supports, accessories, switch gears, control gears, protections, wiring, interconnections, control MCBs. The</p>	Amended as Underlined Sl. No 370

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		Active and Passive components shall be housed in separate compartments." Insulated bus bar pan assembly made from Cu and rated of 1000 Amps capacity. The short circuit withstand capacity shall be 36 KA / 1 Sec (l _{cw}) for the main bus bar and the rated impulse withstand voltage shall be 6 KV.	Active and Passive components shall be housed in separate compartments." Insulated bus bar pan assembly made from Cu and rated of 1000 Amps capacity. The short circuit withstand capacity shall be <u>50</u> KA / 1 Sec (l _{cw}) for the main bus bar and the rated impulse withstand voltage shall be 6 KV.	
82.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 592	F.1.20.1 - Active filter (Rate shall be quoted per Amps) Quantity – 600 Amps	F.1.20.1 - Active filter (Rate shall be quoted per Amps) Quantity – <u>200 Amps</u>	Amended as Underlined
83.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 593	F.1.20.2 - Passive filter(Rate shall be quoted per KVAR) Quantity – 500 kVAR	F.1.20.2 - Passive filter (Rate shall be quoted per KVAR) Quantity – <u>200 kVAR</u>	Amended as Underlined
84.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 796, 802, 807, 812, 817	F.2.18.4 - SITC of 1 No. of 10inch Touch screen 4 button override keypad and accessories with t he cover plate for the same F.2.18.6.5- SITC of 1 No. of 4 button override keypad and accessories with the cover plate for the same F.2.18.7.4 - SITC of 1 No. of 4 button override keypad and accessories with the cover plate for the same	F.2.18.4 - SITC of 1 No. of 10inch Touch screen <u>6</u> button override keypad and accessories with <u>the</u> cover plate for the same F.2.18.6.5 - SITC of 1 No. of <u>6</u> button override keypad and accessories with the cover plate for the same F.2.18.7.4 - SITC of 1 No. of <u>6</u> button override keypad and accessories with the cover plate for the same	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		F.2.18.8.4 - SITC of 1 No. of 4 button override keypad and accessories with the cover plate for the same F.2.18.9.4 - SITC of 1 No. of 4 button override keypad and accessories with the cover plate for the same	F.2.18.8.4 - SITC of 1 No. of <u>6</u> button override keypad and accessories with the cover plate for the same F.2.18.9.4 - SITC of 1 No. of <u>6</u> button override keypad and accessories with the cover plate for the same	
85.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 868	F.3.3 - Supply, Installation, and Terminations conforming to specifications for XLPE insulated, FRLSH (as specified in Schedule F.3.1) and Fire Survival (as specified in Schedule F.3.2) armoured cables of sizes given below including the cost of supplying, fixing and crimping Al/Cu lugs, double compression Flame proof brass glands, shrouds, insulation tape etc. This also includes making holes in gland plate complete as per specifications and as required.	F.3.3 - Supply, Installation and Terminations conforming to specifications for XLPE insulated, FRLSH (as specified in Schedule B.3.1) and Fire Survival (as specified in Schedule B.3.2) armoured cables of sizes given below including the cost of supplying, fixing and crimping <u>electro-tinned copper/ Aluminium / Bi-metallic</u> lugs, double compression <u>Flame proof / Weatherproof</u> brass glands, shrouds, insulation tape etc. This also includes making holes in gland plate complete as per specifications and as required.	Amended as Underlined Sl. No 134, 135, 406
86.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No. 897	F.3.5 - Cable Trays Supply, fabrication & installation of perforated return flanged type cable trays with factory fabricated horizontal & vertical bends, reducers, tee's, cross overs and other accessories as required conforming to IEC-61537. The tray shall be hot dipped galvanized for corrosion protection conforming to DIN 267 Part 10, EN 10346, BS EN ISO 1461, GI return flanged cable trays with 2 mm thick GI sheets conforming to E & M Specifications . The trays shall be tested for minimum safe working load and the deflection should be within the limits as per standard. All accessories including GI angles, threaded rods, fastners, clamps, earthing etc shall be provided (or installed on wall supported on suitable brackets as	F.3.5 - Cable Trays Supply, fabrication & installation of perforated return flanged type cable trays with factory fabricated horizontal & vertical bends, reducers, tee's, cross overs, and other accessories as required conforming to IEC-61537. The tray shall be hot dipped galvanized for corrosion protection conforming to <u>IS 2629</u> , DIN 267 Part 10, EN 10346, BS EN ISO 1461, GI return flanged cable trays with 2 mm thick GI sheets conforming to <u>Technical Specifications and IS Codes</u> . The trays shall be tested for minimum safe working load and the deflection should be within the limits as per standard. All accessories including GI angles, threaded rods, <u>fasteners</u> , clamps etc shall be provided (or installed on wall supported on suitable brackets as required) complete as per specifications, as required and as below.	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		required) complete as per specifications, as required and as below.		
87.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 907	F..3.6 - Supply & installation of cable ladder type tray with factory prefabricated horizontal & vertical bends, reducers, tee's, cross overs and other accessories as required conforming to IEC-61537. The cable ladder shall be hot dipped galvanized for corrosion protection confirming to DIN 267 Part 10, EN 10346, BS EN ISO 1461, GI return flanged cable trays with 2 mm thick GI sheets conforming to E & M Specifications. The cable ladder shall be tested for minimum safe working load & the deflection should be within the limits as per standard. The rung size shall be of 30x15x2mm suitable for fixing the cable clamps & the space between the rungs shall be maximum 300 mm, as required. All accessories including GI angles, threaded rods, fastners, clamps, earthing etc shall be provided (or installed on wall supported on suitable brackets as required) complete as per specifications, as required and as below.	F.3.6 - Supply & installation of cable ladder type tray with factory prefabricated horizontal & vertical bends, reducers, tee's, cross overs, and other accessories as required conforming to IEC-61537. The cable ladder shall be hot dipped galvanized for corrosion protection confirming to <u>IS 2629</u> , DIN 267 Part 10, EN 10346, BS EN ISO 1461, GI return flanged cable trays with 2 mm thick GI sheets conforming to <u>Technical Specifications and IS Codes</u> . The cable ladder shall be tested for minimum safe working load & the deflection should be within the limits as per standard. The rung size shall be of 30x15x2mm suitable for fixing the cable clamps & the space between the rungs shall be maximum 300 mm, as required. All accessories including GI angles, threaded rods, <u>fasteners</u> , clamps etc shall be provided (or installed on wall supported on suitable brackets as required) complete as per specifications, as required and as below.	Amended as Underlined
88.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 911	F.3.7 - Supply, installation and testing of sheet steel two-compartment raceways in floor, fabricated from 1.5 mm thick GI with minimum coating thickness 275 gm / sq. meter on both sides with removable cover plate complete with counter sunk cadmium /steel-plated brass screws, bends, tee-junctions, cross junctions, supports, earthing etc. rendered electrically continuous as approved and of following sizes:	F.3.7 - Supply, installation and testing of sheet steel two-compartment raceways in floor, fabricated from 1.5 mm thick GI with minimum coating on both sides <u>as per Technical Specifications and IS Codes</u> with removable cover plate complete with counter sunk cadmium /steel-plated brass screws, bends, tee-junctions, cross junctions, etc. rendered electrically continuous as approved and of following sizes:	Amended as Underlined
89.	Part 1 Section IV	Supply, installation and testing of sheet steel compartment raceways in surface/suspendent, fabricated from 1.5 mm	Supply, installation and testing of sheet steel compartment raceways in surface/ <u>suspended</u> , fabricated from 1.5 mm	Amended as

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
	B Price Centre F (BOQ6) Sl. No 917	thick GI with minimum coating thickness 275 gm / sq. meter on both sides with removable cover plate complete with counter sunk cadmium /steel-plated brass screws, bends, support rods, tee-junctions, cross junctions, supports, earthing etc. rendered electrically continuous as approved and of following sizes:	thick with minimum coating on both sides <u>as per Technical Specifications and IS Codes</u> with removable cover plate complete with counter sunk cadmium /steel-plated brass screws, bends, support rods, tee-junctions, cross junctions, etc. rendered electrically continuous as approved and of following sizes:	Underlined
90.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No. 927, 930, 933, 936, 943	F.4.1, F.4.2, F.4.3, F.4.4, F.4.5 (Excluding the cost of Conduit, switches, sockets & switch boxes)	F.4.1, F.4.2, F.4.3, F.4.4, F.4.5 (Excluding the cost of Conduit, switches, <u>MCB</u> sockets & switch boxes)	Amended as Underlined Sl. No 16
91.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 976	F.5.1 - SITC of 4' LED batten with wattage $\leq 36W$ and System Efficacy & System lumens of $\geq 119 \text{ lm / W} \geq 4300 \text{ lm}$ respectively. The type of LED shall be SMD type mounted on MCPCB which is mechanically fixed (no glue pasting) with CCT of 6500K and CRI > 80. The housing material shall be CRCA with polyester powder coating. The life of batten shall be 50000 hours at L70. The LED shall be of SDCM < 5. The IP rating of the luminaire shall be IP 20. The ambient temperature shall be 0-45deg C. The luminaire optical element shall be UV protected polycarbonate. The luminaire shall be operable from 140 - 270V AC with PF > 0.9 and THD < 10%. The driver shall be encapsulated type and placed within the luminaire. The driver shall be with in-built surge protection of > 4kV. Drivers shall be flicker free and complies to IEEE P1789	F.5.1 - SITC of 4' LED batten with wattage $\leq 36W$ and System Efficacy & System lumens of $\geq 119 \text{ lm / W} \geq 4300 \text{ lm}$ respectively. The type of LED shall be SMD type mounted on MCPCB which is mechanically fixed (no glue pasting) with CCT of <u>4000K to 5700K</u> and CRI > 80. The housing material shall be CRCA with polyester powder coating. The life of batten shall be 50000 hours at L70. The LED shall be of SDCM < 5. The IP rating of the luminaire shall be IP 20. The ambient temperature shall be 0-45deg C. The <u>luminaire</u> optical element shall be UV protected polycarbonate. The <u>luminaire</u> shall be operable from 140 - 270V AC with PF > 0.9 and THD < 10%. The driver shall be encapsulated type and placed within the luminaire. The driver shall be with in-built surge protection of > 4kV. Drivers shall be flicker free and complies to IEEE P1789 standard; ripple < 5%. The <u>efficiency</u>	Amended as Underlined Sl. No 60

Sl No.	Clause No. ITB/GCC/SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		standard; ripple < 5%. The efficiency of driver shall be > 90%. The luminaire shall be BIS approved and carry "R" number. EMI/EMC Compliance.	of driver shall be > 90%. The luminaire shall be BIS approved and carry "R" number. EMI/EMC Compliance.	
92.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 977	F.5.2 - SITC of LED Bulkhead Luminaire, made of high pressure die-cast aluminium body with polycarbonate diffuser. Optic type: 120 [Beam angle 120°], SDCM: <5. Luminaire should be with minimum system efficacy of 110 Lumen / Watt and minimum system lumen output of 700 maintained at 70% at the end of 50,000 burning hours. The luminaire should have CRI>80 and CCT of 6500K. Luminaire shall meet IP66 and IK09 protection with THD less than 20% and power factor > 0.90 . The total system power should not exceed 6 W including driver losses. Driver efficiency should be 90% . Luminaire should comply with all the required IEC standards and should operate in a voltage range of 140-270 V AC. Surge Protection (Common/Differential): Surge protection level until 2.5 kV. Ambient temperature range: 0 to +45 °C.	F.5.2 - SITC of LED Bulkhead Luminaire, made of high pressure die-cast <u>aluminium</u> body with polycarbonate diffuser. Optic type: 120 [Beam angle 120°], SDCM: <5. Luminaire should be with minimum system efficacy of 110 Lumen / Watt and minimum system lumen output of 700 maintained at 70% at the end of 50,000 burning hours. The luminaire should have CRI>80 and CCT of <u>4000K to 5700K</u> . Luminaire shall meet IP66 and IK09 protection with THD less than 20% and power factor > 0.90. The total system power should not exceed 6 W including driver losses. Driver efficiency should be 90%. Luminaire should comply with all the required IEC standards and should operate in a voltage range of 140-270 V AC. Surge Protection (Common/Differential): Surge protection level until 2.5 kV. Ambient temperature range: 0 to +45 °C.	Amended as Underlined Sl. No 60
93.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 978	F.5.5 - SITC of Surface mounted LED downlighter of ≤ 7W, 230 Volts, 50Hz, surface mounted with attractive metal frame, polycarbonate diffuser and decorative end plates, the system efficacy ≥110 lm / W, power factor more than > 0.95, colour temperature 6500K, system Lumen output ≥ 750 lm and life of LED should not be less than 50,000 burning hours. CRI shall be > 80. The dia of the luminaire shall not be more than 200mm and depth not more than 26mm. The luminaire shall be operable in 140V - 270V 50 HZ. The luminaire shall be BIS approved and carry "R" number. Luminaire shall meet IP20 with THD less than	F.5.5 - SITC of Surface mounted LED downlighter of ≤ 7W, 230 Volts, 50Hz, surface mounted with attractive metal frame, polycarbonate diffuser and decorative end plates, the system efficacy ≥110 lm / W, power factor more than > 0.95, colour temperature <u>4000K to 5700K</u> , system Lumen output ≥ 750 lm and life of LED should not be less than 50,000 burning hours. CRI shall be > 80. The <u>diameter</u> of the luminaire shall not be more than 200mm and depth not more than 26mm. The luminaire shall be operable in 140V - 270V 50 HZ. The luminaire shall be BIS approved and carry "R" number. Luminaire shall meet IP20 with THD less than 20% and	Amended as Underlined Sl. No 60

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		20% and power factor > 0.90 . Driver efficiency should be 90% . Luminaire should comply with all the required IEC standards and should operate in a voltage range of 140-270 V AC. Surge Protection (Common/Differential): Surge protection level until 1.5 kV. Ambient temperature range: 0 to +45 °C.	power factor > 0.90 . Driver efficiency should be 90%. Luminaire should comply with all the required IEC standards and should operate in a voltage range of 140-270 V AC. Surge Protection (Common/Differential): Surge protection level until 1.5 kV. Ambient temperature range: 0 to +45 °C.	
94.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 979	F.5.6 - SITC of 37W LED batten with IP 65 luminaire made of virgin polycarbonate body. The diffuser shall be of UV-shielding polycarbonate diffuser. The luminaire shall be able to deliver a system lumen of 4400 lumens with efficacy of 118 lm / W. The CCT shall be 6500K, CRI shall be > 80. The gasket shall be of silicone. THD<10%, PF > 0.95. Surge protection: Differential mode and common mode - 4kV. The luminaire shall not be with LED TUBE. The luminaire shall be operable for 0 to 45 deg C. The life of luminaire shall be 50000 burning hours @ L70. The driver shall be of encapsulated type. The luminaire and driver shall be BIS approved and shall carry "R" number.	F.5.6 - SITC of 37W LED batten with IP 65 luminaire made of virgin polycarbonate body. The diffuser shall be of UV-shielding polycarbonate diffuser. The luminaire shall be able to deliver a system lumen of 4400 lumens with efficacy of 118 lm / W. The CCT shall be <u>4000K to 5700K</u> , CRI shall be > 80. The gasket shall be of silicone. THD<10%, PF > 0.95. Surge protection: Differential mode and common mode - 4kV. The luminaire shall not be with LED TUBE. The luminaire shall be operable for 0 to 45 deg C. The life of luminaire shall be 50000 burning hours @ L70. The driver shall be of encapsulated type. The luminaire and driver shall be BIS approved and shall carry "R" number.	Amended as Underlined Sl. No 60
95.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 980	F.5.7 - SITC of LED highbay symmetric beam luminaire with housing made of die-cast aluminium of system wattage not more than 157W. The luminaire shall be with dedicated optics to provide precise light distribution of symmetric wide beam angle of FWHM 110°. The luminaire shall be designed to meet its specifications on performance & lifetime at a design ambient temperature of 45 deg C and operating temperature range 0-50° C. A specially designed heat management system to ensure luminous efficacy >=125 lm/ W for the system and ensure lumen depreciation upto 30% over 50k burning hours. The	F.5.7 - SITC of LED high bay symmetric beam luminaire with housing made of die-cast aluminium of system wattage not more than 157W. The luminaire shall be with dedicated optics to provide precise light distribution of symmetric wide beam angle of FWHM 110°. The luminaire shall be designed to meet its specifications on performance & lifetime at a design ambient temperature of 45 deg C and operating temperature range 0-50° C. A specially designed heat management system to ensure luminous efficacy >=125 lm/ W for the system and ensure lumen depreciation up to 30% over 50k burning hours. The luminaire is designed to meet IP	Amended as Underlined Sl. No 60

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		<p>luminaire is designed to meet IP 65 and IK 08 classification and is compliant with relevant immunity, safety and performance and EMI standards. The system lumens shall not be less than 19500 lumens with 6500K CCT. The CRI shall be > 80. The luminaire shall be able operate from 120 - 270V AC, 50Hz with > 0.95 PF & THD <=10%. The LEDs shall be of SMD type (not COB type). The luminaire supplier shall submit the LM79 and LM80 report of the luminaire from the approved NABL accredited laboratory. The luminaire shall be with toughened glass cover. The luminaire shall be with inbuilt surge protection of 4kV. The driver efficiency shall be > 90%. The driver shall be able to withstand 440V (Phase to Phase Protection for 8 Hrs and High cut @ 325±15V and auto Restart.</p>	<p>65 and IK 08 classification and is compliant with relevant immunity, safety and performance and EMI standards. The system lumens shall not be less than 19500 lumens with <u>4000K to 5700K</u> CCT. The CRI shall be > 80. The luminaire shall be able operate from 120 - 270V AC, 50Hz with > 0.95 PF & THD <=10%. The LEDs shall be of SMD type (not COB type). The luminaire supplier shall <u>submit the</u> LM79 and LM80 report of the luminaire from the approved NABL accredited laboratory. The <u>luminaire</u> shall be with toughened glass cover. The luminaire shall be with inbuilt surge protection of 4kV. The driver efficiency shall be > 90%. The driver shall be able to withstand 440V (Phase to Phase Protection for 8 Hrs and High cut @ 325±15V and auto Restart.</p>	
96.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 981	<p>F.5.8 - SITC of LED highbay symmetric beam luminaire with housing made of die-cast aluminium of system wattage not more than 157W. The luminaire shall be with dedicated optics to provide precise light distribution of symmetric wide beam angle of FWHM 60°. The luminaire shall be designed to meet its specifications on performance & lifetime at a design ambient temperature of 45 deg C and operating temperature range 0-50° C. A specially designed heat management system to ensure luminous efficacy >=125 lm/ W for the system and ensure lumen depreciation upto 30% over 50k burning hours. The luminaire is designed to meet IP 65 and IK 08 classification and is compliant with relevant immunity, safety and performance and EMI standards. The system lumens shall not be less than 19500 lumens with 6500K CCT. The CRI</p>	<p>F.5.8 - SITC of LED high bay symmetric beam luminaire with housing made of die-cast aluminium of system wattage not more than 157W. The luminaire shall be with dedicated optics to provide precise light distribution of symmetric wide beam angle of FWHM 60°. The luminaire shall be designed to meet its specifications on performance & lifetime at a design ambient temperature of 45 deg C and operating temperature range 0-50° C. A specially designed heat management system to ensure luminous efficacy >=125 lm/ W for the system and ensure lumen depreciation up to 30% over 50k burning hours. The luminaire is designed to meet IP 65 and IK 08 classification and is compliant with relevant immunity, safety and performance and EMI standards. The system lumens shall not be less than 19500 lumens with <u>4000K to 5700K</u> CCT. The CRI shall be > 80. The luminaire</p>	Amended as Underlined Sl. No 60

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		shall be > 80. The luminaire shall be able operate from 120 - 270V AC, 50Hz with > 0.95 PF & THD <=10%. The LEDs shall be of SMD type (not COB type). The luminaire supplier shall submit the LM79 and LM80 report of the luminaire from the approved NABL accredited laboratory. The luminaire shall be with toughened glass cover. The luminaire shall be with inbuilt surge protection of 4kV. The driver efficiency shall be > 90%. The driver shall be able to withstand 440V (Phase to Phase Protection for 8 Hrs and High cut @ 325±15V and auto Restart.	shall be able operate from 120 - 270V AC, 50Hz with > 0.95 PF & THD <=10%. The LEDs shall be of SMD type (not COB type). The luminaire supplier shall <u>submit</u> the LM79 and LM80 report of the luminaire from the approved NABL accredited laboratory. The <u>luminaire</u> shall be with toughened glass cover. The luminaire shall be with inbuilt surge protection of 4kV. The driver efficiency shall be > 90%. The driver shall be able to withstand 440V (Phase to Phase Protection for 8 Hrs and High cut @ 325±15V and auto Restart.	
97.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 982	F.5.11 - SITC of Surface mounted LED downlighter of 15W, 230 Volts, 50Hz, surface mounted with attractive metal frame, polycarbonate diffuser and decorative end plates, the system efficacy ≥110 lm / W, power factor more than > 0.95, colour temperature 5700K, system Lumen output ≥ 1600 lm and life of LED should not be less than 50,000 burning hours. CRI shall be > 80. The dia of the luminaire shall not be more than 200mm and depth not more than 26mm. The luminaire shall be operable in 140V - 270V 50 HZ. The luminaire shall be BIS approved and carry "R" number. Luminaire shall meet IP20 with THD less than 10% and power factor > 0.90 . Driver efficiency should be 90% . Surge Protection (Common/Differential): Surge protection level until 1.5 kV. Ambient temperature range: 0 to +45 °C.	F.5.11 - SITC of Surface mounted LED downlighter of 15W, 230 Volts, 50Hz, surface mounted with attractive metal frame, polycarbonate diffuser and decorative end plates, the system efficacy ≥110 lm / W, power factor more than > 0.95, colour temperature <u>4000K to 5700K</u> , system Lumen output ≥ 1600 lm and life of LED should not be less than 50,000 burning hours. CRI shall be > 80. The dia of the luminaire shall not be more than 200mm and depth not more than 26mm. The luminaire shall be operable in 140V - 270V 50 HZ. The luminaire shall be BIS approved and carry "R" number. Luminaire shall meet IP20 with THD less than 10% and power factor > 0.90. Driver efficiency should be 90%. Surge Protection (Common/Differential): Surge protection level until 1.5 kV. Ambient temperature range: 0 to +45 °C.	Amended as Underlined
98.	Part 1 Section IV B Price	F.5.14 - SITC of of LED highbay symmetric beam luminaire with housing made of die-cast aluminium of system wattage not more than 105W. The luminaire shall be with dedicated optics to provide precise light	F.5.14 - SITC of LED high bay symmetric beam luminaire with housing made of die-cast aluminium of system wattage not more than 105W. The luminaire shall be with dedicated optics to provide precise light distribution of 110degree beam	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
	Centre F (BOQ6) Sl. No 983	distribution of 110 degree beam angle rotational symmetry. The luminaire shall be designed to meet its specifications on performance & lifetime at a design ambient temperature of -10°C to 45°C (Ta45°C). A specially designed heat management system to ensure luminous efficacy >=130 lm/ W for the system and ensure lumen depreciation upto 30% over 50k burning hours. The luminaire is designed to meet IP66/ IK08 classification and is compliant with relevant immunity, safety and performance and EMI standards. The system lumens shall not be less than 14000 lumens with 5700K CCT. The CRI shall be ≥ 80. The luminaire shall be able operate from 140 - 270V AC, 50Hz with ≥ 0.95 PF & THD <=10%. The luminaire shall have an in-built surge protection upto 4kV. The LEDs shall be SMD type and each LED shall with peanut optics. The luminaire shall be enclosed with flat extra clear tempered glass of 5mm thick. The driver shall be of potted type. The luminaire and driver shall be BIS approved and shall carry "R" number. The driver shall be with High Voltage cutoff & auto restart @320V and Phase to phase 440V protection for 8 hours.	angle rotational symmetry. The luminaire shall be designed to meet its specifications on performance & lifetime at a design ambient temperature of -10°C to 45°C (Ta45°C). A specially designed heat management system to ensure luminous efficacy >=130 lm/ W for the system and ensure lumen depreciation up to 30% over 50k burning hours. The luminaire is designed to meet IP66/ IK08 classification and is compliant with relevant immunity, safety and performance and EMI standards. The system lumens shall not be less than 14000 lumens with <u>4000K to 5700K CCT</u> . The CRI shall be ≥ 80. The luminaire shall be able operate from 140 - 270V AC, 50Hz with ≥ 0.95 PF & THD <=10%. The luminaire shall have an in-built surge protection up to 4kV. The LEDs shall be SMD type, and each LED shall with peanut optics. The luminaire shall be enclosed with flat extra clear tempered glass of 5mm thick. The driver shall be of potted type. The luminaire and driver shall be BIS approved and shall carry "R" number. The driver shall be with High Voltage cut-off & auto restart @320V and Phase to phase 440V protection for 8 hours.	
99.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 984	F.5.15 - SITC of of LED highbay symmetric beam luminaire with housing made of die-cast aluminium of system wattage not more than 105W. The luminaire shall be with dedicated optics to provide precise light distribution of 60 degree beam angle rotational symmetry. The luminaire shall be designed to meet its specifications on performance & lifetime at a design ambient temperature of -10°C to 45°C (Ta45°C). A specially	F.5.15 - SITC of LED high bay symmetric beam luminaire with housing made of die-cast aluminium of system wattage not more than 105W. The luminaire shall be with dedicated optics to provide precise light distribution of 60-degree beam angle rotational symmetry. The luminaire shall be designed to meet its specifications on performance & lifetime at a design ambient temperature of -10°C to 45°C (Ta45°C). A specially designed heat management system to ensure	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		<p>designed heat management system to ensure luminous efficacy ≥ 130 lm/ W for the system and ensure lumen depreciation upto 30% over 50k burning hours. The luminaire is designed to meet IP66/ IK08 classification and is compliant with relevant immunity, safety and performance and EMI standards. The system lumens shall not be less than 14000 lumens with 5700K CCT. The CRI shall be ≥ 80. The luminaire shall be able operate from 140 - 270V AC, 50Hz with ≥ 0.95 PF & THD $\leq 10\%$. The luminaire shall have an in-built surge protection upto 4kV. The LEDs shall be SMD type and each LED shall with peanut optics. The luminaire shall be enclosed with flat extra clear tempered glass of 5mm thick. The driver shall be of potted type. The luminaire and driver shall be BIS approved and shall carry "R" number. The driver shall be with High Voltage cutoff & auto restart @320V and Phase to phase 440V protection for 8 hours.</p>	<p>luminous efficacy ≥ 130 lm/ W for the system and ensure lumen depreciation up to 30% over 50k burning hours. The luminaire is designed to meet IP66/ IK08 classification and is compliant with relevant immunity, safety and performance and EMI standards. The system lumens shall not be less than 14000 lumens with <u>4000K to 5700K</u> CCT. The CRI shall be ≥ 80. The luminaire shall be able operate from 140 - 270V AC, 50Hz with ≥ 0.95 PF & THD $\leq 10\%$. The luminaire shall have an in-built surge protection up to 4kV. The LEDs shall be SMD type, and each LED shall with peanut optics. The luminaire shall be enclosed with flat extra clear tempered glass of 5mm thick. The driver shall be of potted type. The luminaire and driver shall be BIS approved and shall carry "R" number. The driver shall be with High Voltage cut-off & auto restart @320V and Phase to phase 440V protection for 8 hours.</p>	
100.	<p>Part 1 Section IV B Price Centre F (BOQ6) Sl. No 985</p>	<p>F.5.20 - SITC of 70W LED streetlight with 8350 lm, CRI: 80, CCT: 5700K, Efficacy: 120 lm / W, Power Factor: > 0.95, THD: $< 15\%$, Surge protection: inbuilt 4kV and 10kV external, Ingress Protection: IP 66, Impact Resistance: IK 08, Life: 50000 burning hours. A specially designed heat management system to ensure luminous efficacy ≥ 120 lm/ W for the system and ensure lumen depreciation upto 30% over 50k burning hours The housing shall be finless pressure die cast aluminium body with cover made of Polycarbonate. The LEDs shall be SMD type (not COB type) and each LED shall with peanut optics. The driver shall be 140-270 Volt universal electronic potted driver</p>	<p>F.5.20 - SITC of 70W LED streetlight with 8350 lm, CRI: 80, CCT: <u>4000K to 5700K</u>, Efficacy: 120 lm / W, Power Factor: > 0.95, THD: $< 15\%$, Surge protection: inbuilt 4kV and 10kV external, Ingress Protection: IP 66, Impact Resistance: IK 08, Life: 50000 burning hours. A specially designed heat management system to ensure luminous efficacy ≥ 120 lm/ W for the system and ensure lumen depreciation up to 30% over 50k burning hours The housing shall be finless pressure die cast aluminium body with cover made of Polycarbonate. The LEDs shall be SMD type (not COB type) and each LED shall with peanut optics. The driver shall be 140-270 Volt universal electronic potted driver with Internal surge</p>	<p>Amended as Underlined</p>

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		with Internal surge protection of 4kV/kA. The Driver should be potted /encapsulated and not a printed circuit board without casing, mounted inside the luminaire. Both the luminaire and drivers hall be BIS approved and should carry "R" number. Driver Protections: Driver Protections 440V (P2P)Protection for 8 Hrs., High cut off @ 325±15V with Auto Restart.	protection of 4kV/kA. The Driver should be potted /encapsulated and not a printed circuit board without casing, mounted inside the luminaire. Both the luminaire and driver's hall be BIS approved and should carry "R" number. Driver Protections: Driver Protections 440V (P2P) Protection for 8 Hrs., High cut off @ 325±15V with Auto Restart.	
101.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 986	F.5.21 - SITC of LED floodlight with wattage not more than 400W and system lumens not less than 48000 lm with system efficacy of 120 lm / W. The finish of the luminaire shall be Aesthetically designed housing with Grey colour corrosion resistant polyester powder coating along with 500hrs NSS salt painting. The cover of the luminaire shall be Integrated cover made of polycarbonate or toughened glass. The luminaire shall be IP 66 and IK 08 protected. The operating power factor shall be > 0.9 and THD <10%. The efficiency of driver shall be more than 85 % in all cases at all times during project period. The System rating is 50,000 hr @ L70. Correlated Color Temperature should be between 5700 K (Nominal and variation as per ANSI). The value of CRI shall be more than 80. The driver shall be 120-270 Volt universal electronic potted driver with The 10KV/10KA Surge Protection Device (SPD) specifically designed for use in outdoor luminaires and delivers maximum protection for all outdoor lighting applications from excessive surge voltages due to lightning. The Driver should be potted /encapsulated and not a printed circuit board without casing, mounted inside the luminaire. Both the luminaire and drivers hall be BIS approved and should	F.5.21 - SITC of LED floodlight with wattage not more than 400W and system <u>efficacy</u> of 120 lm / W. The finish of the luminaire shall be Aesthetically designed housing with grey colour corrosion resistant polyester powder coating along with 500hrs NSS salt painting. The cover of the luminaire shall be Integrated cover made of polycarbonate or toughened glass. The <u>luminaire</u> shall be IP 66 and IK 08 protected. The operating power factor shall be > 0.9 and THD <10%. The efficiency of driver shall be more than 85 % in all cases at all times during project period. The System rating is 50,000 hr @ L70. Correlated Color Temperature should be between <u>4000K to 5700K</u> (Nominal and variation as per ANSI). The value of CRI shall be more than 80. The driver shall be 120-270 Volt universal electronic potted driver with the 10KV/10KA Surge Protection Device (SPD) specifically designed for use in outdoor luminaires and delivers maximum protection for all outdoor lighting applications from excessive surge voltages due to lightning. The Driver should be potted /encapsulated and not a printed circuit board without casing, mounted inside the luminaire. Both the luminaire and driver's hall be BIS approved and should carry "R" number. Driver Protections:	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		carry "R" number. Driver Protections: Driver Protections 440V (P2P)Protection for 8 Hrs., High cut off @ 325±15V with Auto Restart.	Driver Protections 440V (P2P) Protection for 8 Hrs., High cut off @ 325±15V with Auto Restart.	
102.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 990	F.5.25 - Supply Installation Testing & Commissioning of surface/suspended 22SWG CRCA sheet White epoxy polyester powder Coated housing emergency Light . Total lumen output minimum 200 lumens, power consumption 4.7Watts, Over charge protection and deep charge protection for battery, 16-24 hours charging time, 3 hours backup time for battery, CCT 4000 to 5700K, CRI>80 with SDCM<5 with IP-20, IK08 protection, P.F>0.95, surge protection of 4kV, THD <10%, 3.6V/2Ah NimH Battery, Red indication for charging the light as indicated on luminaire. The lifeclass of the luminaire should be 50000 burning hours at L70 and luminaire as per tehcnical specification. Area applicable: Admin Building and workshop.	F.5.25 - Supply Installation Testing & Commissioning of surface/suspended emergency Light. Total lumen output minimum <u>660 lumens</u> , power consumption <u>6Watts</u> , over charge protection and deep charge protection for battery, 16-24 hours charging time, 3 hours backup time for battery, CCT 4000 to 5700K, CRI>80 with SDCM<5 with IP-20, IK08 protection, P.F>0.95, surge protection of 4kV, THD <10%, 3.6V/2Ah NimH Battery, Red indication for charging the light as indicated on luminaire. The <u>life class</u> of the luminaire should be 50000 burning hours at L70 and luminaire as per <u>technical specification</u> . Area applicable: concourse and platform entrances	Amended as Underlined
103.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 991	F.5.26 -Supply Installation Testing & Commissioning of Recessed LED Down Lighter with PDC aluminium housing with high efficiency polycarbonate diffuser. Total lumen output package of minimum 1470 lumens with system efficacy of >110lumen/watt, CCT 4000 to 5700K, CRI>80, SDCM<5 with min IP-20 protection. The lifeclass of the luminaire should be 50000 burning hours at L70B50 .The electronic driver used shall have a power factor >0.95, THD <10%. Area applicable for Toilet Area	F.5.26 -Supply Installation Testing & Commissioning of Recessed LED Down Lighter with PDC aluminium housing with high efficiency polycarbonate diffuser. Total lumen output package of minimum 1470 lumens with system efficacy of >110lumen/watt, CCT <u>4000 to 5700K</u> , CRI>80, SDCM<5 with min IP-20 protection. The life class of the luminaire should be 50000 burning hours at <u>L70</u> .The electronic driver used shall have a power factor >0.95, THD <10%. Area applicable for Toilet Area	Amended as Underlined
104.	Part 1 Section IV B Price	F.5.29 - Supply Installation Testing & Commissioning of 16w LED PIT light with intgreal control gear made of Die cast aluminium housing comprising of White (WH) LEDs	F.5.29 - Supply Installation Testing & Commissioning of 16w LED PIT light with <u>integral</u> control gear made of Die cast aluminium housing comprising of White (WH) LEDs	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
	Centre F (BOQ6) Sl. No 993	connected in series and parallel. Engg. Plastic end caps with frosted polycarbonate cover .Driver: Constant current output driver, operating range 140 -270V AC supply voltages.Rotatable mounting brackets provided for ease of installation with IP-66 & IK10 protection & LEDs are provided with secondary lens optics to get optimum optical performance and CCT 6000 to 6500k with a power factor PF > 0.95 to be provided & Should not less than 90 lumens / watt. Should be provided for the control gear THD < 10%. The product should compliance for DRIVER Compliance to safety requirements Photo biological. Compliance IEC 62471. Area applicable for Workshop Bay Pit Lighting (Equivalent to Jaquar industrial Pit lights)	connected in series and parallel. Engg. Plastic end caps with frosted polycarbonate cover. Driver: Constant current output driver, operating range 140 -270V AC supply voltages. Rotatable mounting brackets provided for ease of installation with IP-66 & IK10 protection & LEDs are provided with secondary lens optics to get optimum optical performance and CCT <u>4000K to 5700K</u> with a power factor PF > 0.95 to be provided & should not less than 90 lumens / watt. Should be provided for the control gear THD < 10%. The product should compliance for DRIVER Compliance to safety requirements Photo biological. Compliance IEC 62471. Area applicable for Workshop Bay Pit Lighting (Equivalent to Jaquar industrial Pit lights)	Sl. No 60
105.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 995	F.5.26 - SITC of Highbay luminaire having PDC aluminium with tempered glass cover and PC lens. The luminaire shall have total lumen package of minimum 10500 lumens with system efficacy of >130lumen/watt, CCT 6500K, CRI>70 with SDCM<5 with min IP-66 and IK-08 protection. The life class of the luminaire should be 50000 burning hours at L70 @ design ambient temp 45 deg C. Driver should have P.F>0.95, surge protection of 4kV, THD <10%. Luminaire shall have input voltage range of 140-270V with cut off and auto restart voltage at 325V AC. Area applicable for double height areas in building.	<u>F.5.30</u> - SITC of High Bay luminaire having PDC aluminium with tempered glass cover and PC lens. The luminaire shall have total lumen package of minimum 10500 lumens with system efficacy of >130lumen/watt, CCT <u>4000K to 5700K</u> , CRI>70 with SDCM<5 with min IP-66 and IK-08 protection. The life class of the luminaire should be 50000 burning hours at L70 @ design ambient temp 45 deg C. Driver should have P.F>0.95, surge protection of 4kV, THD <10%. Luminaire shall have input voltage range of 140-270V with cut off and auto restart voltage at 325V AC. Area applicable for double height areas in building.	Amended as Underlined Sl. No 60
106.	Part 1 Section IV B Price Centre F (BOQ6)	F.5.27 - SITC of LED flood light with a system lumen output of 8500 lumens. The luminaire shall have PDC Al. housing and a minimum system efficacy of 115 lumen/watt. CRI> 70 with rated system lifetime of 50,000 hours at L70. It must conform to Protection Classification	<u>F.5.31</u> - SITC of LED flood light with a system lumen output of 8500 lumens. The luminaire shall have PDC Al. housing and a minimum system efficacy of 115 lumen/watt. CRI> 70 with rated system lifetime of 50,000 hours at L70. It must conform to Protection Classification of IP 66, IK-07, CCT of	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
	Sl. No 996	of IP 66, IK-07, PF>0.95, in-built surge protection of 4kV, THD <10%. Luminaire shall have input voltage range of 140-270V with cut off and auto restart voltage at 325V AC. Area applicable for External area wall Light	<u>4000K to 5700K</u> , PF>0.95, in-built surge protection of 4kV, THD <10%. Luminaire shall have input voltage range of 140-270V with cut off and auto restart voltage at 325V AC. Area applicable for External area wall Light	
107.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 997	F.5.28 - SITC of LED flood light with a system lumen output of 3500 lumens. The luminaire shall have PDC Al. housing and a minimum system efficacy of 100 lumen/watt. CRI> 70 with rated system lifetime of 50,000 hours at L70. It must conform to Protection Classification of IP 66, IK-07, PF>0.95, in-built surge protection of 4kV, THD <10%. Luminaire shall have input voltage range of 140-270V with cut off and auto restart voltage at 325V AC. Area applicable for External area wall Light	<u>F.5.32</u> - SITC of LED flood light with a system lumen output of 3500 lumens. The luminaire shall have PDC Al. housing and a minimum system efficacy of 100 lumen/watt. CRI> 70 with rated system lifetime of 50,000 hours at L70. It must conform to Protection Classification of IP 66, IK-07, PF>0.95, CCT of <u>4000K to 5700K</u> , in-built surge protection of 4kV, THD <10%. Luminaire shall have input voltage range of 140-270V with cut off and auto restart voltage at 325V AC. Area applicable for External area wall Light	Amended as Underlined
108.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 998	F.5.29 - SITC of LED Highbay with PDC Aluminium housing and toughened and shatter-proof quality glass cover. The luminaire should have SDCM < 5, CRI > 80 and CCT of 5700K with IP66, IK08 protection. Luminaire should emit at least 19800 nominal lumens at a system efficacy of atleast 126 lumen/watt. The luminaire shall be designed so as to ensure lumen depreciation of up to 30% over 50k burning hours @ design ambient temp 45 deg C. Driver shall have P.F>0.95 and THD <10% with a minimum inbuilt surge protection of 4kV. Area applicable for Inspection Bay	<u>F.5.33</u> - SITC of LED High Bay with PDC Aluminium housing and toughened and shatter-proof quality glass cover. The luminaire should have SDCM < 5, CRI > 80 and CCT of 4000K to 5700K with IP66, IK08 protection. Luminaire should emit at least 19800 nominal lumens at a system efficacy of <u>at least</u> 126 lumen/watt. The luminaire shall be designed to ensure lumen depreciation of up to 30% over 50k burning hours @ design ambient temp 45 deg C. Driver shall have P.F>0.95 and THD <10% with a minimum inbuilt surge protection of 4kV. Area applicable for Inspection Bay	Amended as Underlined
109.	Part 1 Section IV B Price Centre F (BOQ6)	F.5.30 - SITC of LED Highbay Fixture with PDC housing to provide excellent corrosion-resistance and robustness, and PC Lens with Dual Optics to provide high quality Glare free lighting. The heat sink should be made of Al die cast, shall be designed in such a way that air ventilation should	<u>F.5.34</u> - SITC of LED High Bay Fixture with PDC housing to provide excellent corrosion-resistance and robustness, and PC Lens with Dual Optics to provide high quality Glare free lighting. The heat sink should be made of Al die cast, shall be designed in such a way that air ventilation should be best all	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
	Sl. No 999	be best all across. System lumen output of 26000 lumens and a minimum system efficacy of 125 lumen/watt. The luminaire shall have CRI>80, 50,000 hours at L70, SDCM < 5, CCT of 5700K with IP66, IK08 protection. Driver should comply with THD<10%, P.F>0.95. Area applicable for Workshop Bay.	across. System lumen output of 26000 lumens and a minimum system efficacy of 125 lumen/watt. The luminaire shall have CRI>80, 50,000 hours at L70, SDCM < 5, CCT of <u>4000K to 5700K</u> with IP66, IK08 protection. Driver should comply with THD<10%, P.F>0.95. Area applicable for Workshop Bay.	
110.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 1055	F.7.4 - Supply, laying, termination, Testing and commissioning of PVC insulated, FRLSH, Copper Cables for Earthing in green colour, as per IS 7098 and Specifications, for interconnecting the earth station with METs of the following sizes in trenches/surface/wall/ground complete with accessories as per specifications & drawing as required.	F.7.4 - Supply, laying, termination, Testing and commissioning of <u>XLPE insulated, PVC Sheathed, FRLSH, Flexible (Unarmoured)</u> Copper Cables for Earthing in green colour, as per IS 7098 and Specifications, for interconnecting the earth station with METs of the following sizes in trenches/surface/wall/ground complete with accessories as per specifications & drawing as required.	Amended as Underlined Sl. No 375
111.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 1065	F.7.6 - SITC of plate earthing station with 1200 mm x 1200 mm x 6.3 mm G. I. plate electrode, 50 mm dia G.I. watering pipe, GI funnel with wire mesh earth enhancing compound Material, all earth work, masonry enclosure with frame, Heavy duty RCC top cover plate having locking arrangement, Disconnecting links, complete as per IS 3043:1987 for earthing.(Including civil work)	F.7.6 - SITC of plate earthing station with <u>1200 mm x 1200 mm x 12 mm</u> G. I. plate electrode, 50 mm dia G.I. watering pipe, GI funnel with wire mesh earth enhancing compound Material, all earth work, masonry enclosure with frame, Heavy duty RCC top cover plate having locking arrangement, disconnecting links, complete as per IS 3043:1987 for earthing. (Including civil work)	Amended as Underlined Sl. No 138

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No																														
112.	Part 1 Section IV B Price Centre F (BOQ6) SI. No 1097	<table border="1"> <tr> <td>F.8.1 - supply & installation of the following items Horizontal Mesh for lightning Protection</td> <td>5640.00</td> <td>Metre</td> </tr> <tr> <td>Roof Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm², of Material- SS 304 & TESTED as per Standard EN 62561-2.</td> <td></td> <td></td> </tr> <tr> <td>Polyamide/Stainless Steel, Material thickness- 2.5 mm, is capable of holding Rod 8 mm & Complied as per Standard IEC 62305. With accessories self-threaded screw and washers, Material SS 304 (M10x25mm), Glue(Cartage), Expansion Pieces & MV Clamps.</td> <td></td> <td></td> </tr> <tr> <td>Universal connector of Material- Stainless Steel, with clamping range- 8-10mm, with truss head screw M10x35 mm & Complied as per Standard EN 62561-1.</td> <td></td> <td></td> </tr> </table>	F.8.1 - supply & installation of the following items Horizontal Mesh for lightning Protection	5640.00	Metre	Roof Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm ² , of Material- SS 304 & TESTED as per Standard EN 62561-2.			Polyamide/Stainless Steel, Material thickness- 2.5 mm, is capable of holding Rod 8 mm & Complied as per Standard IEC 62305. With accessories self-threaded screw and washers, Material SS 304 (M10x25mm), Glue(Cartage), Expansion Pieces & MV Clamps.			Universal connector of Material- Stainless Steel, with clamping range- 8-10mm, with truss head screw M10x35 mm & Complied as per Standard EN 62561-1.			<table border="1"> <tr> <td>F.8.1 - supply & installation of the following items Horizontal Mesh for lightning Protection <u>consists of below</u></td> <td>5640.00</td> <td>Metre</td> </tr> <tr> <td>Roof Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm², of Material- SS 304 & TESTED as per Standard EN 62561-2.</td> <td></td> <td></td> </tr> <tr> <td>Polyamide/Stainless Steel, Material thickness- 2.5 mm, is capable of holding Rod 8 mm & Complied as per Standard IEC 62305. With accessories self-threaded screw and washers, Material SS 304 (M10x25mm), Glue(Cartage), Expansion Pieces & MV Clamps.</td> <td></td> <td></td> </tr> <tr> <td>Universal connector of Material- Stainless Steel, with clamping range- 8-10mm, with truss head screw M10x35 mm & Complied as per Standard EN 62561-1.</td> <td></td> <td></td> </tr> </table>	F.8.1 - supply & installation of the following items Horizontal Mesh for lightning Protection <u>consists of below</u>	5640.00	Metre	Roof Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm ² , of Material- SS 304 & TESTED as per Standard EN 62561-2.			Polyamide/Stainless Steel, Material thickness- 2.5 mm, is capable of holding Rod 8 mm & Complied as per Standard IEC 62305. With accessories self-threaded screw and washers, Material SS 304 (M10x25mm), Glue(Cartage), Expansion Pieces & MV Clamps.			Universal connector of Material- Stainless Steel, with clamping range- 8-10mm, with truss head screw M10x35 mm & Complied as per Standard EN 62561-1.			Amended as Underlined						
F.8.1 - supply & installation of the following items Horizontal Mesh for lightning Protection	5640.00	Metre																																
Roof Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm ² , of Material- SS 304 & TESTED as per Standard EN 62561-2.																																		
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Universal connector of Material- Stainless Steel, with clamping range- 8-10mm, with truss head screw M10x35 mm & Complied as per Standard EN 62561-1.																																		
F.8.1 - supply & installation of the following items Horizontal Mesh for lightning Protection <u>consists of below</u>	5640.00	Metre																																
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113.	Part 1 Section IV B Price Centre F (BOQ6) SI. No 1101	<table border="1"> <tr> <td>F.8.2 - Supply & installation of the following items Air Termination for lightning Protection</td> <td></td> <td></td> </tr> <tr> <td>Air-termination rod having length- 1000 mm of Material- Cu of Diameter Ø 16 mm, & Complied as per Standard EN 62561-2</td> <td></td> <td></td> </tr> <tr> <td>Side Wall Clamp for 1 mtr., air terminal</td> <td></td> <td></td> </tr> <tr> <td>Air-termination rod clamps for connecting air-termination rods with one or two conductors. Material of clamp SS 304 , with clamping range of air-termination rod 16 mm and Clamping range of conductor Rod 2x 8 mm, & Complied as per Standard EN 62561-1.</td> <td>50.00</td> <td>Set</td> </tr> <tr> <td>Fixing Clamp for air terminal connecting two conductors in parallel manner. Material- Stainless Steel, with clamping range- Rod / Rod 8 mm & Complied as per Standard IEC 62305</td> <td></td> <td></td> </tr> </table>	F.8.2 - Supply & installation of the following items Air Termination for lightning Protection			Air-termination rod having length- 1000 mm of Material- Cu of Diameter Ø 16 mm, & Complied as per Standard EN 62561-2			Side Wall Clamp for 1 mtr., air terminal			Air-termination rod clamps for connecting air-termination rods with one or two conductors. Material of clamp SS 304 , with clamping range of air-termination rod 16 mm and Clamping range of conductor Rod 2x 8 mm, & Complied as per Standard EN 62561-1.	50.00	Set	Fixing Clamp for air terminal connecting two conductors in parallel manner. Material- Stainless Steel, with clamping range- Rod / Rod 8 mm & Complied as per Standard IEC 62305			<table border="1"> <tr> <td>F.8.2 - Supply & installation of the following items Air Termination for lightning Protection <u>consists of below</u></td> <td>50.00</td> <td>Set</td> </tr> <tr> <td>Air-termination rod having length- 1000 mm of Material- Cu of Diameter Ø 16 mm, & Complied as per Standard EN 62561-2</td> <td></td> <td></td> </tr> <tr> <td>Side Wall Clamp for 1 mtr., air terminal</td> <td></td> <td></td> </tr> <tr> <td>Air-termination rod clamps for connecting air-termination rods with one or two conductors. Material of clamp SS 304 , with clamping range of air-termination rod 16 mm and Clamping range of conductor Rod 2x 8 mm, & Complied as per Standard EN 62561-1.</td> <td></td> <td></td> </tr> <tr> <td>Fixing Clamp for air terminal connecting two conductors in parallel manner. Material- Stainless Steel, with clamping range- Rod / Rod 8 mm & Complied as per Standard IEC 62305</td> <td></td> <td></td> </tr> </table>	F.8.2 - Supply & installation of the following items Air Termination for lightning Protection <u>consists of below</u>	50.00	Set	Air-termination rod having length- 1000 mm of Material- Cu of Diameter Ø 16 mm, & Complied as per Standard EN 62561-2			Side Wall Clamp for 1 mtr., air terminal			Air-termination rod clamps for connecting air-termination rods with one or two conductors. Material of clamp SS 304 , with clamping range of air-termination rod 16 mm and Clamping range of conductor Rod 2x 8 mm, & Complied as per Standard EN 62561-1.			Fixing Clamp for air terminal connecting two conductors in parallel manner. Material- Stainless Steel, with clamping range- Rod / Rod 8 mm & Complied as per Standard IEC 62305			Amended as Underlined
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Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No																								
114.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 1108 to 1111	<table border="1"> <tr> <td>F.8.3.2 - Down Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm², of Material- SS 304 & Complied as per Standard EN 62561-2</td> <td>2230.00</td> <td>Set</td> </tr> <tr> <td>Conductor holder for Brick of Material- Stainless Steel/Weather proof (Polyamide), Material thickness- 2.5 mm, is capable of holding Rd 8 mm & Complied as per Standard IEC 62305 With accessories self-threaded screw</td> <td></td> <td></td> </tr> <tr> <td>Test Joint (Folding Clamp) with intermediate plate for round and flat conductor of Material- Stainless Steel, Material thickness- 2.5 mm, with clamping range- Rd / FI 8-10 / 30 mm, & Complied as per Standard EN 62561-1.</td> <td></td> <td></td> </tr> <tr> <td>Providing of flat conductor holder as per Standard IEC 62305. Installed with 2 hexagonal bolts.</td> <td></td> <td></td> </tr> </table>	F.8.3.2 - Down Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm ² , of Material- SS 304 & Complied as per Standard EN 62561-2	2230.00	Set	Conductor holder for Brick of Material- Stainless Steel/Weather proof (Polyamide), Material thickness- 2.5 mm, is capable of holding Rd 8 mm & Complied as per Standard IEC 62305 With accessories self-threaded screw			Test Joint (Folding Clamp) with intermediate plate for round and flat conductor of Material- Stainless Steel, Material thickness- 2.5 mm, with clamping range- Rd / FI 8-10 / 30 mm, & Complied as per Standard EN 62561-1.			Providing of flat conductor holder as per Standard IEC 62305. Installed with 2 hexagonal bolts.			<table border="1"> <tr> <td>F.8.3.2 - Down Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm², of Material- SS 304 & Complied as per Standard EN 62561-2 <u>Consists of below</u></td> <td>2230.00</td> <td>Set</td> </tr> <tr> <td>Conductor holder for Brick of Material- Stainless Steel/Weather proof (Polyamide), Material thickness- 2.5 mm, is capable of holding Rd 8 mm & Complied as per Standard IEC 62305 With accessories self-threaded screw</td> <td></td> <td></td> </tr> <tr> <td>Test Joint (Folding Clamp) with intermediate plate for round and flat conductor of Material- Stainless Steel, Material thickness- 2.5 mm, with clamping range- Rd / FI 8-10 / 30 mm, & Complied as per Standard EN 62561-1.</td> <td></td> <td></td> </tr> <tr> <td>Providing of flat conductor holder as per Standard IEC 62305. Installed with 2 hexagonal bolts.</td> <td></td> <td></td> </tr> </table>	F.8.3.2 - Down Conductor of Diameter Ø- 8 mm, Cross-section- 50 mm ² , of Material- SS 304 & Complied as per Standard EN 62561-2 <u>Consists of below</u>	2230.00	Set	Conductor holder for Brick of Material- Stainless Steel/Weather proof (Polyamide), Material thickness- 2.5 mm, is capable of holding Rd 8 mm & Complied as per Standard IEC 62305 With accessories self-threaded screw			Test Joint (Folding Clamp) with intermediate plate for round and flat conductor of Material- Stainless Steel, Material thickness- 2.5 mm, with clamping range- Rd / FI 8-10 / 30 mm, & Complied as per Standard EN 62561-1.			Providing of flat conductor holder as per Standard IEC 62305. Installed with 2 hexagonal bolts.			Amended as Underlined
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115.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 1113	F.9.1 - Supply of 2 x 120 KVA True Online Double Conversion, Modular type, Parallel Redundant, 3 Phase AC Input & 3 Phase AC Output, expandable UPS System having an Ingress protection Rating of IP 21 (as per E & M Specifications) consisting of the following:	F.9.1 - Supply of 2 x 120 KVA True Online Double Conversion, Parallel Redundant, 3 Phase AC Input & 3 Phase AC Output, expandable UPS System having an Ingress protection Rating of IP 21 (as per <u>Technical Specifications</u>) consisting of the following:	As Amended																								
116.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 1125	F.10.1 - Design, manufacture, testing at works, supplying, testing of sheet steel structure of following rating (Amps) of Fire rated Sandwich type TPN "Cu" bus duct having neutral cross section equal to phase, 50% Internal earth bus and Class F insulation and enclosure will be of minimum 1.6 mm GI sheet steel/2.5mm AL sheet epoxy powder coated. The bus bar will be of copper with radialised edges. Individual sections will not be more than 3 meters long uniblock. One section will be connected to adjacent section by joint system operating by single bolt.	F.10.1 - Design, manufacture, testing at works, supplying, testing of sheet steel structure of following rating (Amps) of Fire rated Sandwich type TPN "Cu" bus duct having neutral cross section equal to phase, 50% Internal earth bus and Class F insulation and enclosure will be of minimum 1.6 mm GI sheet steel/2.5mm AL sheet epoxy powder coated. The bus bar will be of copper with radialised edges. Individual sections will not be more than 3 meters long uniblock. One section will be connected to adjacent section by joint system operating by single bolt. Sub assembly shall be removable	Amended as Underlined Sl. No 155																								

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		Sub assembly shall be removable without disturbing the adjacent bus bars. Rates shall be inclusive of all accessories i.e. bends, wall flanges, end feed box, the bus duct etc. as required	without disturbing the adjacent bus bars. Rates shall be inclusive of all accessories i.e. bends, wall flanges, end feed box, <u>2 Runs of 50mm x 6mm Copper flat along the length of the bus duct etc. as required.</u>	
117.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 1169	a) 1250 A, 415V, 35 KA, 4 Pole, Electrically operated Draw Out type ACB, complete with safety shutters, 240V AC shunt trip coil & closing coil and having microprocessor based releases with LCD Display and provision for (1) SCADA monitoring and control capability with Ethernet Port TCP/ IP Communication (2) Provision for measurement of V,I,W,VAR,VA,Wh,VARh and power factor (3) Protection against long time + short time + earth fault (all with adjustable time delays as mentioned in the Technical specification) + instantaneous,over & under voltage, minimum and maximum frequency ,voltage and current imbalance,phase sequence,load shedding and reconnection (4) Measurement of interrupted currents, differentiated fault indications, maintenance indicators (5) Last five trippings and event histories and time stamping with facility for consulting the history file, maintenance indicator register etc (6) Communication module to remotely read and set parameters for the protection functions, transmission of all the calculated indicators and measurements (7) Signaling of the cause of tripping and alarms (8) NO/NC contacts for interlocks and indications and also necessary accessories.	a) 1250 A, 415V, <u>36 KA</u> , 4 Pole, Electrically operated Draw Out type ACB, complete with safety shutters, 240V AC shunt trip coil & closing coil and having microprocessor based releases with LCD Display and provision for (1) SCADA monitoring and control capability with Ethernet Port TCP/ IP Communication (2) Provision for measurement of V, I, W, VAR, VA, Wh, VARh and power factor (3) Protection against long time + short time + earth fault (all with adjustable time delays as mentioned in the Technical specification) + instantaneous, over & under voltage, minimum and maximum frequency ,voltage and current imbalance, phase sequence, load shedding and reconnection (4) Measurement of interrupted currents, differentiated fault indications, maintenance indicators (5) Last five <u>tripping's</u> and event histories and time stamping with facility for consulting the history file, maintenance indicator register etc (6) Communication module to remotely read and set parameters for the protection functions, transmission of all the calculated indicators and measurements (7) <u>Signalling</u> of the cause of tripping and alarms (8) NO/NC contacts for interlocks and indications and also necessary accessories.	Amended as Underlined
118.	Part 1 Section IV B Price	Electrolytic high conductivity T P & N (100%) + 50% earth,tinned electrolytic grade(whole length of the panel) copper conductor bus-bars with heat shrinkable insulation	Electrolytic high conductivity T P & N (100%) + 50% earth, tinned electrolytic grade (whole length of the panel) copper conductor <u>busbars</u> with heat shrinkable insulation sleeves	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
	Centre F (BOQ6) Sl. No 1188	sleeves conforming to BS EN13601, (as specified in specifications) rated 1250 Amps, suitable to withstand symmetrical fault level of 35kA for 1 second at 415 volts.	conforming to BS EN13601, (as specified in specifications) rated 1250 Amps, suitable to withstand symmetrical fault level of <u>36kA</u> for 1 second at 415 volts.	
119.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 1191	a) 630 A, 415V, 25kA, 4 Pole, Electrically operated Draw Out type ACB, complete with safety shutters, 240V AC shunt trip coil & closing coil and having microprocessor based releases with LCD display Provision for measurement of V, A, W, VAR, VA, Wh, VARh, Hz, power factor etc, Protection against Overload, Short circuit and earth fault (all with adjustable time delays), Measurement of interrupted currents, differentiated fault indications, maintenance indicators ,Last five trippings and event histories and time stamping with facility for consulting the history file, maintenance indicator register etc ,Communication module to remotely read and set parameters for the protection functions,inbuilt Ethernet provisions for communication, transmission of all the calculated indicators and measurements, Signaling of the cause of tripping and alarms, NO/NC contacts for interlocks and indications and also necessary accesories.	a) 630 A, 415V, <u>36kA</u> , 4 Pole, Electrically operated Draw Out type ACB, complete with safety shutters, 240V AC shunt trip coil & closing coil and having microprocessor based releases with LCD display Provision for measurement of V, A, W, VAR, VA, Wh, VARh, Hz, power factor etc, Protection against Overload, Short circuit and earth fault (all with adjustable time delays), Measurement of <u>interrupted</u> currents, <u>differentiated</u> fault indications, maintenance indicators ,Last five <u>tripping's</u> and event histories and time stamping with facility for consulting the history file, maintenance indicator register etc ,Communication module to remotely read and set parameters for the protection functions, inbuilt Ethernet provisions for communication, transmission of all the calculated indicators and measurements, <u>Signalling</u> of the cause of tripping and alarms, NO/NC contacts for interlocks and indications and also necessary <u>accessories</u> .	Amended as Underlined
120.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 1198	a) 400A ,4P, 415V, 25kA, MCCB with 240V AC shunt trip coil and having microprocessor release with LCD display (1)SCADA monitoring and control capability (2)Provision for measurement of three phase current(3) Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) + Instantaneous (4) Clear indication of type of fault	a) 400A ,4P, 415V, <u>36kA</u> , MCCB with 240V AC shunt trip coil and having microprocessor release with LCD display (1)SCADA monitoring and control capability (2)Provision for measurement of three phase current(3) Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) + Instantaneous (4) Clear indication of type of fault when	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		when tripped etc.(5) NO / NC contacts for interlocks and indications (6) Status Indication ON, OFF, TRIP.7)1 No. CT in the neutral to connect with the trip unit.	tripped etc.(5) NO / NC contacts for interlocks and indications (6) Status Indication ON, OFF, TRIP.7)1 No. CT in the neutral to connect with the trip unit.	
121.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 1203	a) 63A ,4P, 415V, 25kA, MCCB with 240V AC shunt trip coil and having microprocessor release with LCD display (1)SCADA monitoring and control capability (2)Provision for measurement of three phase current(3) Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) + Instantaneous (4) Clear indication of type of fault when tripped etc.(5) NO / NC contacts for interlocks and indications (6) Status Indication ON, OFF, TRIP.7)1 No. CT in the neutral to connect with the trip unit.	a) 63A ,4P, 415V, <u>36kA</u> , MCCB with 240V AC shunt trip coil and having microprocessor release with LCD display (1)SCADA monitoring and control capability (2)Provision for measurement of three phase current(3) Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) + Instantaneous (4) Clear indication of type of fault when tripped etc.(5) NO / NC contacts for interlocks and indications (6) Status Indication ON, OFF, TRIP.7)1 No. CT in the neutral to connect with the trip unit.	Amended as Underlined
122.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 1221, 1224	F.11.5.1 - For DG sets upto 750 KVA ratings units - Jobs F.11.6.1 - For DG sets upto 750 KVA ratings units - Jobs	F.11.5.1 - For DG sets upto 750 KVA ratings units - <u>Lots</u> F.11.6.1 - For DG sets upto 750 KVA ratings units - <u>Lots</u>	Amended as Underlined Sl. No 380
123.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 1225		New item added <u>F.12 - Supply, installation, Testing and commission of bus cable 2R x 2C x 0.5 Sq.mm EIB twisted pair cable to connect all Keypad and all LCPs.: Quantity - 250 meters</u>	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
124.	Part 1 Section IV B Price Centre F (BOQ6) Sl. No 1226		<p>New item added</p> <p><u>F.13 - Design, Supply, Installation Testing & Commissioning of each AHF Panel to achieve unity P.F and THDI / THD V less than 5%. It shall comply to IEEE 519-2014. The PQ Solution should have an income of 1000 A ACB and shall be rated for 1000 Amps, 415V, +/- 10 % 50Hz, 3 phase, 50KA, 3 Phase, 4 Wire System. IP rating shall be IP42. The active compensation shall be 3 level Topology 12-IGBT based certified by UL. It should filter harmonics from 2nd to 51st individual harmonic order and shall be selectable for the entire range. CT position could be Load side or Grid side and the CT secondary could be either 1A or 5A. It should communicate to BMS/SCADA through HMI. The Panel must be duly housed in epoxy powder coated 2mm thick CRCA sheet steel semi compartmentalised enclosure free standing type with all supports, accessories, switch gears, control gears, protections, wiring, interconnections, control MCBs. Insulated bus bar pan assembly made from Cu and rated and rated for suitable current rating. The short circuit withstand capacity shall be 50KA / 1 Sec (Icw) for the main bus bar and the rated impulse withstand voltage shall be 6 KV.</u></p> <p><u>AHF panel shall do harmonic mitigation, power factor correction, imbalance, and neutral compensation. Active Filter, Standards compliance/certification as per</u></p>	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
			<p><u>Specification. The AHF Panel, should also have an energy server which would collect, store, and provides web access and visualization to various energy parameters and enable remote supervision.</u> <u>Quantity – 1300 Amps</u></p>	
125.	Part 1 Section IV B Price Centre G (BOQ 7) Sl. No 17	G.1.2 - Supply, installation, testing & commissioning of diesel Engine driven common stand by pump, horizontal centrifugal split case pumping set with CI body, bronze impeller, with stainless steel shaft, sleeve and gland packing to ensure a minimum pressure of 3.5 kg/sq.cm. at highest and farthest outlet at specified flow of 2850 LPM at 135 metres m. head conforming to IS 1520 / IS: 12469 -1988. Suitable HP, 1500 RPM / 2950 RPM water cooled with radiator diesel engine conforming to relevant IS standard complete with auto starting mechanism 12V,180AH Batteries & battery leads with stand, Diesel Tank (Fuel tank) with stand & gauge glass, Fuel tank shall be of 4mm thick sheet,Fuel piping with valves, includes coupling gaurd, and other stanadard accessories residential silencer, instruments and protection as per specification, stop solenoid for auto stop in the event of fault with audio indications, painted with post office red colour, include Exhaust pipe of required length and size to discharge exhaust gases externally, with muffler, day oil tank of 586 ltrs capacity with first charge and hand pump set,complete and the capacity of the day tank should be 5-8 Hrs of the SFC with support structure anchoring arrangement, with all controls and valves. etc. as reqd.RCC foundation (as recommended by	G.1.2 - Supply, installation, testing & commissioning of diesel Engine driven common stand by pump, horizontal centrifugal split case pumping set with CI body, bronze <u>impeller</u> , with stainless steel shaft, sleeve and gland packing to ensure a minimum pressure of 3.5 kg/sq.cm. at highest and farthest outlet at specified flow of 2850 LPM at 135 metres m. head conforming to IS 1520 / IS: 12469 -1988. Suitable HP, water cooled with radiator diesel engine conforming to relevant IS standard complete with auto starting mechanism 12V,180AH Batteries & battery leads with stand, Diesel Tank (Fuel tank) with stand & gauge glass, Fuel tank shall be of 4mm thick sheet, Fuel piping with valves, includes coupling <u>guard</u> , and other <u>standard</u> accessories residential silencer, instruments and protection as per specification, stop solenoid for auto stop in the event of fault with audio indications, painted with post office red colour, include Exhaust pipe of required length and size to discharge exhaust gases externally, with muffler, day oil tank of <u>minimum 250 litres</u> capacity with first charge and hand pump set, complete and the capacity of the day tank should be 5-8 Hrs of the SFC with support structure	Amended as underlined. Sl. No.65, 141, 312

Sl No.	Clause No. ITB/GCC/SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		manufacturere) and G.I.fabricated Common base plate, coupling, coupling guard, foundation bolts etc.as required. Suitable cement concrete foundation duly plastered with anti vibration pads. (For Hydrant & Sprinkler System).	anchoring arrangement, with all controls and valves. etc. as <u>required</u> . RCC foundation (<u>will be done by Civil contractor</u>) and G.I. fabricated Common base plate, coupling, coupling guard, foundation bolts etc.as required. Suitable cement concrete foundation duly plastered with anti-vibration pads. (For Hydrant & Sprinkler System).	
126.	Part 1 Section IV B Price Centre G (BOQ 7) Sl. No 68	G.3.2 Supply, Installation, Testing and Commissioning of UL listed / FM approved Gate Valves with rising stem (OS & Y) with grooved end of the following sizes as per Specifications. and Pressure rating of Gate valves Rising Type: max working pressure 300 psi(21 bar)	G.3.2 Supply, Installation, Testing and Commissioning of UL listed / FM approved Gate Valves with rising stem (OS & Y) with grooved end of the following sizes as per Specifications. and Pressure rating of Gate valves Rising Type: working pressure <u>of 16 bar</u> .	Amended as underlined.
127.	Part 1 Section IV B Price Centre G (BOQ 7) Sl. No 86	G.3.5 Supply, Installation, Testing and Commissioning of UL listed / FM approved Duct iron 'Y' type Strainers with grooved ends of the following sizes with nuts, bolts, gaskets etc. complete in all respect as describedd in Specifications.	G.3.5 Supply, Installation, Testing and Commissioning of UL listed <u>Ductile</u> iron 'Y' type Strainers with grooved ends of the following sizes with nuts, bolts, gaskets etc. complete in all respect as <u>described</u> in Specifications.	Amended as underlined.
128.	Part 1 Section IV B Price Centre G (BOQ 7) Sl. No 102	G.3.11 Supply and installation of UL listed / FM approved stainless steel Expansion Bellow, suitable for PN 16 requirements as per Specifications.	G.3.11 Supply and installation of stainless-steel Expansion Bellow, suitable for PN 16 requirements as per Specifications.	Amended as underlined. Sl. No 257
129.	Part 1 Section IV B Price	G.7.1 - Design, Supply, Installation, testing & Commisioning of Novec 1230 Fire Suppression System Automatic Clean Agent Novec 1230 (UL/VDs/FM	<u>G.7</u> - Design, Supply, Installation, testing & <u>Commissioning</u> of Novec 1230 Fire Suppression System Automatic Clean Agent Novec 1230 (UL/VDs/FM approved - Fire Detection &	Amended as underlined.

Sl No.	Clause No. ITB/GCC/SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No																								
	Centre G (BOQ 7) Sl. No 196, 200, 201, 202	approved - Fire Detection & Suppression System, Consisting of the following Rooms as per Specification and drawings. <table border="1"> <tr> <td>G.7.2- 150 Kg Cylinder with Novec 1230 and Accessories</td> <td>4 Nos</td> </tr> <tr> <td>G.7.3 - 120 Kg Cylinder with Novec 1230 and Accessories</td> <td>4 Nos</td> </tr> <tr> <td>G.7.4 - 80 Kg Cylinder with Novec 1230 and Accessories</td> <td>2 Nos</td> </tr> </table>	G.7.2- 150 Kg Cylinder with Novec 1230 and Accessories	4 Nos	G.7.3 - 120 Kg Cylinder with Novec 1230 and Accessories	4 Nos	G.7.4 - 80 Kg Cylinder with Novec 1230 and Accessories	2 Nos	Suppression System, Consisting of the following Rooms as per Specification and drawings <table border="1"> <tr> <td>G.7.1- <u>140 L Cylinder Capacity with minimum filling of 112kg Novec 1230 clean agent and Accessories</u></td> <td>1 Nos</td> </tr> <tr> <td>G.7.2 – <u>120 L Cylinder Capacity with minimum filling of 96kg Novec 1230 clean agent and Accessories</u></td> <td><u>10</u> Nos</td> </tr> <tr> <td>G.7.3 – <u>80 L Cylinder Capacity with minimum filling of 65kg Novec 1230 clean agent and Accessories</u></td> <td>1 Nos</td> </tr> </table>	G.7.1- <u>140 L Cylinder Capacity with minimum filling of 112kg Novec 1230 clean agent and Accessories</u>	1 Nos	G.7.2 – <u>120 L Cylinder Capacity with minimum filling of 96kg Novec 1230 clean agent and Accessories</u>	<u>10</u> Nos	G.7.3 – <u>80 L Cylinder Capacity with minimum filling of 65kg Novec 1230 clean agent and Accessories</u>	1 Nos													
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130.	Part 1 Section IV B Price Centre G (BOQ 7) Sl. No 203, 207, 213 to 228	<table border="1"> <tr> <td>G.7.5 - Master Cylinder Accessories</td> <td>10 Set</td> </tr> <tr> <td>G.7.6 - End Slave Cylinder Accessories</td> <td>10 Set</td> </tr> <tr> <td>G.7.5 - Common Parts Of Novec 1230</td> <td></td> </tr> <tr> <td>G.7.5.1 - Manifold Check Valve 2"</td> <td>14 Nos</td> </tr> <tr> <td>G.7.5.2 - Discharge Nozzles</td> <td>14 Nos</td> </tr> <tr> <td>G.7.5.3 - Discharge Pressure Switch</td> <td>7 Nos</td> </tr> </table>	G.7.5 - Master Cylinder Accessories	10 Set	G.7.6 - End Slave Cylinder Accessories	10 Set	G.7.5 - Common Parts Of Novec 1230		G.7.5.1 - Manifold Check Valve 2"	14 Nos	G.7.5.2 - Discharge Nozzles	14 Nos	G.7.5.3 - Discharge Pressure Switch	7 Nos	<table border="1"> <tr> <td>G.7.4 - Master Cylinder Accessories</td> <td>6 Set</td> </tr> <tr> <td>G.7.5 - End Slave Cylinder Accessories</td> <td>6 Set</td> </tr> <tr> <td>G.7.6 - Common Parts of Novec 1230</td> <td></td> </tr> <tr> <td>G.7.6.1 - Manifold Check Valve 2"</td> <td><u>12</u> Nos</td> </tr> <tr> <td>G.7.6.2 - Discharge Nozzles</td> <td><u>12</u> Nos</td> </tr> <tr> <td>G.7.6.3 - Discharge Pressure Switch</td> <td><u>6</u> Nos</td> </tr> </table>	G.7.4 - Master Cylinder Accessories	6 Set	G.7.5 - End Slave Cylinder Accessories	6 Set	G.7.6 - Common Parts of Novec 1230		G.7.6.1 - Manifold Check Valve 2"	<u>12</u> Nos	G.7.6.2 - Discharge Nozzles	<u>12</u> Nos	G.7.6.3 - Discharge Pressure Switch	<u>6</u> Nos	Amended as underlined.
G.7.5 - Master Cylinder Accessories	10 Set																											
G.7.6 - End Slave Cylinder Accessories	10 Set																											
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SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing		As Amended		Remarks/ Pre-Bid Query SI. No
		G.7.5.4 - Seamless (Carbon Steel) Piping for Fire suppression Cylinder with all fittings like, manifolds, flanges, bends, tees, elbows, reducers, GI clamps, GI hangers etc. with painting	7 Lot	G. <u>7.6.4</u> - Seamless (Carbon Steel) Piping for Fire suppression Cylinder with all fittings like, manifolds, flanges, bends, tees, elbows, reducers, GI clamps, GI hangers etc. with painting	<u>6</u> Lot	
		G.7.5.5 - Conventional 4 Zone Gas Release panel with Battery Backup and seamless connectivity with Main FACP	7 Nos	G. <u>7.6.5</u> - Conventional 4 Zone Gas Release panel with Battery Backup and seamless <u>connectivity</u> with Main FACP	<u>6</u> Nos	
		G.7.5.6 - Conventional Photo Electric Smoke Detector with base - System Sensor	14 Nos	G. <u>7.6.6</u> - Conventional Photo Electric Smoke Detector with base - System Sensor	<u>12</u> Nos	
		G.7.5.7 - Conventional Heat Detector - System Sensor	14 Nos	G. <u>7.6.7</u> - Conventional Heat Detector - System Sensor	<u>12</u> Nos	
		G.7.5.8 - Response indicator	7 Nos	G. <u>7.6.8</u> - Response indicator	<u>6</u> Nos	
		G.7.5.9 - Gas Release Switch	7 Nos	G. <u>7.6.9</u> - Gas Release Switch	<u>6</u> Nos	
		G.7.5.10 - Abort Switch	7 Nos	G. <u>7.6.10</u> - Abort Switch	<u>6</u> Nos	
		G.7.5.11 - Horn Strobe for Indoor Application-High volume - UL Listed	7 Nos	G. <u>7.6.11</u> - Horn Strobe for Indoor Application-High volume - UL Listed	<u>6</u> Nos	
		G.7.5.12 - Fire Alarm Bell for Indoor Application	7 Nos	G. <u>7.6.12</u> - Fire Alarm Bell for Indoor Application	<u>6</u> Nos	

SI No.	Clause No. ITB/GCC/SCC/Forms	As Existing		As Amended		Remarks/ Pre-Bid Query SI. No
		G.7.5.13 - Gas discharge warning sign LED panel	7 Nos	G. <u>7.6.13</u> - Gas discharge warning sign LED panel	<u>6</u> Nos	
		G.7.5.14 - GI Cable Tray 100mm Width X 50mm height with cover	350 RM	G. <u>7.6.14</u> - GI Cable Tray 100mm Width X 50mm height with cover	350 RM	
		G.7.5.15 - 2C X 1.5 Sq.mm Overall Shield Fire Survivial Red Color Outer Sheath Armoured Cable	1400 RM	G. <u>7.6.15</u> - 2C X 1.5 Sq.mm Overall Shield Fire <u>Survival</u> Red Color Outer Sheath Armoured Cable	1400 RM	
131.	Part 1 Section IV B Price Centre H (BOQ8) Sl. No 13	H.2.1 - 10 HP (8 TR) Quantity - 2		H.2.1 - 10 HP (8 TR) <u>Quantity -1</u>		Amended as underlined. Sl. No 391
132.	Part 1 Section IV B Price Centre H (BOQ8) Sl. No 14	H.2.2 - 14 HP (11.2TR) Quantity – 2		H.2.2 - 14 HP (11.2TR) <u>Quantity -6</u>		Amended as underlined. Sl. No 391
133.	Part 1 Section IV B Price Centre H (BOQ8) Sl. No 35,36	H.6 - DX SYSTEM Supply, Installation, Testing and Commissioning of inverter type DX unit /Hi-Wall Split air conditioning units of specified capacities with R410A / Equivalent refrigerant gas fillinC. The indoor units shall be wall fixing type. The Indoor unit shall comprise of Blower, Cooling coil, Filter and Expansion device. The Outdoor unit shall comprise of scroll / rotary Compressor, Air cooled condenser &		H.6 - DX SYSTEM Supply, Installation, Testing and Commissioning of inverter type DX unit /Hi-Wall Split air conditioning units of specified capacities with R410A / Equivalent refrigerant gas <u>filling</u> . The indoor units shall be wall fixing type. The Indoor unit shall comprise of Blower, Cooling coil, Filter and Expansion device. The Outdoor unit shall comprise of scroll / rotary Compressor, Air cooled condenser & Condenser fans. The		Amended as underlined.

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No
		<p>Condenser fans. The outdoor unit shall be installed as per the tender drawings. Scope shall include all supports for the indoor and outdoor units. Rate inclusive of suitable voltage remote controller wireless/remote stabilizer, drain kit pump, cabling for 20.Amp's contactor with NO+NC (for remote operation through BMS) and control cable. The unit shall be sized to deliver following rated capacities minimum which excludes derated capacity due to excess length of refrigeration pipes, different elevation, and the ambient temperature of 40 deg C. The details of the calculation sheets should be submitted with shop drawings. The quote should be inclusive of drain pump Refrigerant Piping, Stabilizer, installation mounting accessories and the unit shall be of High efficiency and BEE 5-star rating.</p>	<p>outdoor unit shall be installed as per the tender drawings. Scope shall include all supports for the indoor and outdoor units. Rate inclusive of suitable voltage remote controller wireless/remote stabilizer, drain kit pump, cabling for <u>20 Amp's contactor with minimum of 3 NO + 2 NC or as recommended by the OEM</u> (for remote operation through BMS) and control cable. The unit shall be sized to deliver following rated capacities minimum which excludes derated capacity due to excess length of refrigeration pipes, different elevation, and the ambient temperature <u>of 52 deg C</u>. The details of the calculation sheets should be submitted with shop drawings. The quote should be inclusive of drain pump Refrigerant Piping, Stabilizer, installation mounting accessories and the unit shall be of High efficiency and BEE 5-star rating.</p>	
134.	<p>Part 1 Section IV B Price Centre H (BOQ8) SI. No 34</p>	<p>H.5.6 - SS 304 Secodar drain pan with insulation for IDU as per Technical specifications</p>	<p><u>H.3.4 - SS 304 Secondary drain pan with insulation for IDU as per technical specifications</u></p>	<p>Amended as underlined. SI. No 249</p>
135.	<p>Part 1 Section IV B Price Centre H (BOQ8) SI. No 40</p>	<p>Supply, Installation, Testing and Commissioning of Interconnecting refrigerant pipe work (Hard drawn copper tubes shall be used. Soft copper tubes shall be used up to 12.7 mm diameter) with closed cell elastomeric nitrile rubber tubular insulation wrapped with treated woven glass cloth between each set of indoor & outdoor units as per specification . Refrigerant gas line tubes shall insulate</p>	<p>Supply, Installation, Testing and Commissioning of Interconnecting refrigerant pipe work (Hard drawn copper tubes shall be used. Soft copper tubes shall be used up to 12.7 mm diameter) with closed cell elastomeric nitrile rubber tubular insulation wrapped with treated woven glass cloth between each set of indoor & outdoor units as per specification. Refrigerant gas line tubes shall insulate with 25</p>	<p>As Amended</p>

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		with 25 mm thickness nitrile rubber for the size up to 15.9 mm outer diameter, 32 mm thickness nitrile rubber for the size above 15.9 mm outer diameter copper tubes and 13 mm thickness nitrile rubber for liquid line copper tubes. All piping shall be properly laid in covered perforated Cable tray & supported with Galvanised steel hanger as per specification and typical installation drawings. (Copper tubes shall comply with ASTM B 280-16).	mm thickness nitrile rubber for the size up to 15.9 mm outer diameter, 32 mm thickness nitrile rubber for the size above 15.9 mm outer diameter copper tubes and 13 mm thickness nitrile rubber for liquid line copper tubes. (Copper tubes shall comply with ASTM B 280-16).	
136.	Part 1 Section IV B Price Centre H (BOQ8) Sl. No 95	H.12.1 - Supply, installation, testing and commissioning of 2 core / 3 core 1.5 sqmm cross section shielded Signal/Communication cable as recommended by OEM conforming IEC/IS standard, installed in perforated cable tray with GI conduits between indoor and Outdoor units.	H.12.1 - Supply, installation, testing and commissioning of 2 core / 3 core 1.5 sqmm cross section shielded Signal/Communication cable as recommended by OEM conforming IEC/IS standard, between indoor and Outdoor units.	As Amended.
137.	Part 1 Section IV B Price Centre H (BOQ8) Sl. No 150,151, 152, 153	H.23.1 - Manufacture, Supply, Delivery, Installation, Testing, Commissioning of High volume, low speed (HVLS) fans shall be licensed to bear the AMCA Certified Rating Seal for Circulating Fan Performance to ensure performance. Entire fan assembly shall be UL-Listed to Underwriters Laboratory (UL) Standard 507. HVLS Fans shall be quote as per technical specification including control panel, HMI, communication cable, tray or conduit with wiring and necessary vibration mounts with their supports etc. 4.2 m dia , Quantity – 35 Nos 3.05 m dia, Quantity – 04 Nos	H.23.1 - Manufacture, Supply, Delivery, Installation, Testing, Commissioning of High volume, low speed (HVLS) fans shall be licensed to bear the AMCA Certified Rating Seal for Circulating Fan Performance to ensure performance. Entire fan assembly shall be UL-Listed to Underwriters Laboratory (UL) Standard 507. HVLS Fans shall be quote as per technical specification including control panel, HMI, communication cable, tray, or conduit with wiring and necessary vibration mounts with their supports etc. 4.2 <u>metre</u> dia, Quantity – <u>14 Nos</u> 3.05 <u>metre</u> dia, Quantity – 04 Nos 2.45 <u>metre</u> dia, Quantity – 04 Nos	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		2.45 m dia, Quantity – 04 Nos		
138.	Part 1 Section IV B Price Centre H (BOQ8) Sl. No 180, 181		<p>New item added <u>H.29- Axial Flow Fans</u> <u>Supply, installation, testing & commissioning of Fire rated, and non-fire rated Axial flow fans including motors, anti-vibration mounts, suitable supports and flexible sleeves and all accessories shall be as per Specifications and equipment Schedule.</u> <u>H.29.1- Ventilation Exhaust Fan (VEF) 6.1 cms, 400 Pa Total Pressure (fire rated) Nos. 1</u></p>	Amended as Underlined
139.	Part 1 Section IV B Price Centre H (BOQ8) Sl. No 182, 183		<p>New item added <u>H.30 - HVLS FAN (High Volume Low Speed)</u> <u>H.30.1 - Manufacture, Supply, Delivery, Installation, Testing, Commissioning of High volume, low speed (HVLS) fans shall be licensed to bear the AMCA Certified Rating Seal for Circulating Fan Performance to ensure performance. Entire fan assembly shall be UL-Listed to Underwriters Laboratory (UL) Standard 507. HVLS Fans shall be quote as per technical specification including control panel, HMI, communication cable, tray or conduit with wiring and necessary vibration mounts with their supports etc.</u> <u>7.3 metre dia, Quantity – 8 Nos</u></p>	Amended as Underlined
140.	Part 1 Section IV B Price Centre I	c. Software & Graphics f. Amplifier card	c. Software & Graphics <u>(to be loaded in the Depot SCADA Workstation)</u> f. Deleted	Amended as underlined. Sl. No 352, 353

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
	(BOQ9 - I.1.1) Sl. No 6			
141.	Part 1 Section IV B Price (BOQ12) Sl. No 1		<u>General:</u> <u>This BoQ sheet applicable only for Rate only items. Contract price doesn't include these item rates. However, these rates will be evaluated during financial evaluation.</u>	Amended as Underlined. Sl. No 106, 377
142.	Part 1 Section IV B (BOQ12) Sl. No 31		New item added <u>3.7 - FANS</u> <u>Supply and installations of 230 V single phase, 1440 RPM, sweep of approx. 400mm Bracket Fan including mounting bracket, blades, starters, & other standard accessories complete as required. - Quantity - 1</u>	Amended as Underlined
143.	Part 1 Section IV B (BOQ12) Sl. No 32 to 34		New item added <u>4 - Pre-action Systems</u> <u>Providing, Fixing, Testing and Commissioning of UL listed / FM approved of Pre-action Systems. Double-Interlocked Electric / Pneumatic air Including All Valves & Fittings and including Release Panel with FM Approved 2" (50 MM) & other Accessories for Consisting of the Batter Rooms as per Specification and drawings.</u> <u>Providing, Fixing, Testing and Commissioning of UL listed / FM approved. 15 mm diameter K 80 designed Quartzoid Bulb type Sprinkler Set designed to operate at 68 Degree</u>	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
			<p><u>Centigrade including UL listed Sprinkler Guard.as per Specifications</u> <u>4.1 - Approximate Battery Room Area - 15 sqm (Height - 4.8 m) "</u> <u>4.2 - Approximate Battery Room Area - 30 sqm (Height - 4.8 m) "</u></p>	
144.	Part 1 Section IV B (BOQ12) Sl. No 35 to 38		<p>New item added <u>5 - Dismantling of existing Diesel generator set from CMRL Premises and reassembling the same as for function as per specification</u> <u>Removal, Transporting, Positioning, Installation, Testing and Commissioning existing 1No.750 KVA Acoustic enclosure DG set & and its Isolator panels, fuel piping, exhaust systems pipelines, reconnecting the same at new locations with required necessary man power & tools accessories as required as per the site conditions. Rate inclusive of Supply and laying of necessary power, control & communication cabling from generator engine panel to generator control panel and Day tank with suitable gland, crimping sockets and earthing etc in prepared trench/ cable tray for DG sets. .Also removal of existing exhaust chimney with its MS structure if required interconnecting exhaust pipe lines with Al. cladding & painting etc as required as per the site conditions & The successful tenderer should check & ensure the above DG set`s synchronising controller model whether it would</u></p>	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
			<p><u>be matched with existing DG sets & if required supply the same with for trouble free auto sync operations The same shall be erected over constructed/existing foundation with any necessary modifications & minor civil works shall be required as per the site conditions.</u></p> <p><u>Note: In case of any service and repair/modification shall be made to fit the functional requirements. This includes Transport and Delivery at site including Insurance, Handling. Unloading and Safe Keeping etc at site complete Erection and Installation on foundation, connection to accessories and components, Integrating the performance of all Sub Systems components, Testing, Commissioning and Performance Testing including all connected Structural, Electrical and Civil works required for the proper and efficient functioning of DG sets as required Charges towards supply of fuel, lube oil, and other consumables etc, as required, for testing and commissioning and trial run for 10 hrs shall be included</u></p> <p><u>5.1 - 910kVA DG – 1 Lot</u> <u>5.2 - 250kVA DG – 1 Lot</u></p>	
145.	Part 1 Section IV B (BOQ12) Sl. No 39		<p>New item added</p> <p><u>6 - Obtaining statutory approval including preparation of necessary drawings and documentation Liaison with CEIG, Preparation of working drawings, getting approval and obtaining safety certificates for energisation of D.G. Sets. Obtaining statutory approval from Tamil Nadu Pollution</u></p>	Amended as Underlined

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No
			<u>Control Board for clearance from noise and smoke pollution - 1 Lumpsum</u>	
146.	Part 1 Section IV B (BOQ12) Sl. No 40 to 54		<p>New item added</p> <p><u>7 - Supply of True Online Double Conversion, Modular Type, Parallel Redundant, 3 Phase AC Input & 3 Phase AC Output, expandable UPS System having an Ingress protection Rating of IP 21 (as per E & M Specifications) consisting of the following:</u></p> <p><u>UPS Paralleling kit for switchover to redundant unit in case of failure of either UPS.</u></p> <p><u>K 13, copper Galvanic Isolation Transformer for each UPS.</u></p> <p><u>IGBT Rectifier Modules to achieve less than 5% Input Current Distortion and 0.99 Power Factor at Input</u></p> <p><u>Completely Microprocessor based with Diagnostics capability</u></p> <p><u>Maintenance by-pass module.</u></p> <p><u>Isolation switches / MCCB for UPS as per Drawings & Specification and automatic battery bank coupler of MCCB box with 2 pole DC MCCB of suitable rating for battery bank.</u></p> <p><u>Other features as specified in Technical Specification</u></p> <p><u>Installation, Testing and Commissioning Three Phase UPS System (complete) supplied vide Item above.</u></p> <p><u>7.1 - 2 x 120 kVA UPS – 1 Set</u></p> <p><u>7.2 - Each UPS having Lithium-ion battery racks having minimum 1 hours back up time at full load as per</u></p>	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
			<p><u>specifications with interconnecting cables, racks and standard accessories for 2 x 120 kVA UPS, in built Battery Management system. – 1 Set</u> <u>7.3 - 2 x 50 kVA UPS – 1 Set</u> <u>7.4 - Each UPS having Lithium-ion battery racks having minimum 1 hours back up time at full load as per specifications with interconnecting cables, racks and standard accessories for 2 x 50 kVA UPS, in built Battery Management system. – 1 Set</u> <u>7.5 - 2 x 30 kVA UPS – 1 Set</u> <u>7.6 - Each UPS having Lithium-ion battery racks having minimum 1 hours back up time at full load as per specifications with interconnecting cables, racks and standard accessories for 2 x 30 kVA UPS, in built Battery Management system. – 1 Set</u></p>	
147.	Part 1 Section IV B (BOQ12) Sl. No 55 to 61		<p>New item added <u>8 Addition Deletion Items</u> <u>8.1 Adjustment rates for addition/deletion of supply & fixing of following including making of suitable holes/space in the panel/DBs and making good all external finishes, terminations etc. complete as required.</u> <u>Multiple LED type indications</u> <u>Astronomic digital Timer</u> <u>Ammeter/Voltmeter (4-digit display)</u> <u>TP Contactor - 32 to 63 Amp.</u></p>	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
148.	Part 1 Section IV B (BOQ12) Sl. No 62 to 70		<p><u>Aux. Contact 1 NO + 1NC for MCB</u></p> <p>New item added</p> <p><u>8.2 Adjustment rates for addition/deletion of compartmentalized switchgear in above panels/board of following rating including the supply, fabrication, extension, modification of the enclosure or in a separate enclosure, earthing, busbar, other sub-systems, accessories etc. complete as required and as per specifications.</u></p> <p><u>8.2.1 - 1 no. 1250 A, 415V, 50kA, 4P draw out Electrically operated ACB complete with:</u></p> <p><u>a) 1- set Red/Green/ Amber ON/OFF/TRIP indicating lamps</u></p> <p><u>b) 1- set of three phase (red, yellow, blue) indicating lamps</u></p> <p><u>c) 3 nos. cast resin current transformers of 1250/5A ratio with 15 VA Burden & Class 5P10 for protection</u></p> <p><u>d) 3 nos. cast resin current transformers of 1250/5A ratio with 15VA burden and Class 0.2s for measurement</u></p> <p><u>e) Microprocessor based release having variable range of overcurrent, short circuit, UVR and earth fault protection with time log facility for each of the fault for achieving discrimination along with distinct fault indication through LED's.</u></p> <p><u>f) Terminals to receive Copper XLPE armoured cables</u></p> <p><u>g) Ethernet port for display of ON/OFF status of ACB on BMS workstation through MODBUS protocol</u></p>	Amended as Underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
149.	Part 1 Section IV B (BOQ12) Sl. No 71 to 77		<p>New item added <u>8.2.2 - 1 no. 800 A, 415V, 50kA, 4P draw out Electrically operated ACB complete with:</u> <u>a) 1- set Red/Green/ Amber ON/OFF/TRIP indicating lamps</u> <u>b) 1- set of three phase (red, yellow, blue) indicating lamps</u> <u>c) 3 nos. cast resin current transformers of 800/5A ratio with 15VA burden and Class 0.2s for measurement</u> <u>d) Microprocessor based release having variable range of overcurrent, short circuit, UVR and earth fault protection with time log facility for each of the fault for achieving discrimination along with distinct fault indication through LED's.</u> <u>e) Terminals to receive Copper XLPE armoured cables</u> <u>f) Ethernet port for display of ON/OFF status of ACB on BMS workstation through MODBUS protocol</u></p>	Amended as Underlined
150.	Part 1 Section IV B (BOQ12) Sl. No 78 to 84		<p>New item added <u>8.2.3 - 1 no. 630 A, 415V, 50kA, 4P draw out Electrically operated ACB complete with:</u> <u>a) 1- set Red/Green/ Amber ON/OFF/TRIP indicating lamps</u> <u>b) 1- set of three phase (red, yellow, blue) indicating lamps</u> <u>c) 3 nos. cast resin current transformers of 630/5A ratio with 15VA burden and Class 0.2s for measurement</u></p>	Amended as Underlined

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No
			<p><u>d) Microprocessor based release having variable range of overcurrent, short circuit, UVR and earth fault protection with time log facility for each of the fault for achieving discrimination along with distinct fault indication through LED's.</u></p> <p><u>e) Terminals to receive Copper XLPE armoured cables</u></p> <p><u>f) Ethernet port for display of ON/OFF status of ACB on BMS workstation through MODBUS protocol</u></p>	

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
151.	Part 1 Section IV B (BOQ12) Sl. No 85 to 88		<p>New item added</p> <p><u>8.2.4 - 400A 415V, 36/25kA, 4P MCCB with 240V AC shunt trip coil and having microprocessor release with LCD display (1)SCADA monitoring and control capability (2)Provision for measurement of three phase current(3) Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) + Instantaneous (4) Clear indication of type of fault when tripped etc.(5) NO / NC contacts required as per Vendor GA drawing for interlocks and indications (6) Status Indication ON, OFF, TRIP, R, Y, B.</u></p> <p><u>8.2.5 - 400A 415V, 36/25kA, TP MCCB with 240V AC shunt trip coil and having microprocessor release with LCD display (1)SCADA monitoring and control capability (2)Provision for measurement of three phase current(3) Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) + Instantaneous (4) Clear indication of type of fault when tripped etc.(5) NO / NC contacts for interlocks and indications required as per Vendor GA drawing (6) Status Indication ON, OFF, TRIP.7)1 No. CT in the neutral to connect with the trip unit.</u></p> <p><u>8.2.6 - 250A 415V, 36/25kA, 4P MCCB with 240V AC shunt trip coil and having microprocessor release with LCD display (1)SCADA monitoring and control capability (2)Provision for</u></p>	Amended as Underlined

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No
			<p><u>measurement of three phase current(3) Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) + Instantaneous (4) Clear indication of type of fault when tripped etc.(5) NO / NC contacts required as per Vendor GA drawing for interlocks and indications (6) Status Indication ON, OFF, TRIP, R, Y, B.</u></p> <p><u>8.2.7 - 250A 415V, 36/25kA, TP MCCB with 240V AC shunt trip coil and having microprocessor release with LCD display (1)SCADA monitoring and control capability (2)Provision for measurement of three phase current(3) Protection against Overload (with base setting and fine adjustment), Short Circuit and earth fault (all with adjustable time delays) + Instantaneous (4) Clear indication of type of fault when tripped etc.(5) NO / NC contacts required as per Vendor GA drawing for interlocks and indications (6) Status Indication ON, OFF, TRIP.7)1 No. CT in the neutral to connect with the trip unit.</u></p>	

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
152.	Part 1 Section IV B (BOQ12) Sl. No 89 to 93		<p>New item added</p> <p><u>8.2.8 - 200A, 415V, Ics=25 kA, 4P, MCCB with variable over current and short circuit releases and 1-set of three phase indicating lamps (red, yellow, blue), ON, OFF, TRIP</u></p> <p><u>8.2.9 - 200 A ,415V, Ics=25kA, TP, MCCB with variable over current and short circuit releases with heavy duty solid neutral link and 1-set of indicating lamps (ON, OFF, TRIP)</u></p> <p><u>8.2.10 - 160 A, 415V, Ics=25 kA ,4P, MCCB with variable over current and short circuit releases with heavy duty solid neutral link and 1-set of three phase indicating lamps, ON, OFF, TRIP</u></p> <p><u>8.2.11 - 125 A, 415V, Ics=25/16 kA ,4P, MCCB with variable over current and short circuit releases with heavy duty solid neutral link and 1-set of three phase indicating lamps, ON, OFF, TRIP</u></p> <p><u>8.2.12 - 100/63 A, 415V, Ics=25/16 kA ,4P, MCCB with variable over current and short circuit releases with heavy duty solid neutral link and 1-set of three phase indicating lamps, ON, OFF, TRIP</u></p>	Amended as Underlined
153.			<p>New item added</p> <p><u>9. Supply, Manufacture and Testing of the following rating of Mobile Diesel Generator Set along with 4-Wheeler trolley with required number of jacks and towing hooks capable of shifting from one place to another place conforming to standard as per BS 5514 / ISO 3046 / ISO 8528 and meeting</u></p>	

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No
			<p><u>the latest CPCB norms. DG kW rating to be considered at 0.8 PF, 415 V, 50 Hz, 3 phase, 4 wire Alternator of the rating given below at ambient temperature as per specification to meet the functional requirement.</u> <u>This includes Supply, Transport and Delivery at site including Insurance, Handling, Unloading and Safe Keeping etc. at site, connection to all accessories and components, Integrating the performance of all Sub Systems, Testing, Commissioning and Performance Testing including all connected Structural, Electrical and Civil works required for the proper and efficient functioning of DG sets as required.</u> <u>9.1 – 100 kVA – 2 Nos</u></p>	
154.	Part 1 Section IV B Price Centre	Revised Tender BoQ	Addendum-1 BoQ can be downloaded from the following link: C4 EM05 -Addendum BoQ	Amended as Underlined



CHENNAI METRO RAIL LIMITED

CHENNAI METRO RAIL PROJECT PHASE 2, CORRIDOR 4

TENDER No. C4-E&M-05

Supply, installation, testing, commissioning and training of Electrical, Fire protection and VAC works for 18 Elevated stations from Power House Station to Poonamallee Bypass station including Viaduct between the stations (Ch 10027.102 to Ch 25928.186), approach ramp, including Poonamallee Depot for Corridor 4 of Chennai Metro Rail Project Phase-II

PART - 1

BIDDING PROCEDURES

MARCH 2022

3.2.1.1 PRICE VARIATION FORMULA FOR CABLES (IEEMA):

i) For Aluminium conductor PVC Insulated 1.1 Kv Power Cables :

$$P = P_0 + AIF(AI-AI_0) + CCFAl(PVCC-PVCC_0) + FeF(Fe - Fe_0)$$

For unarmoured multicore cables(without steel armour) $FeF=0$.

ii) Copper conductor PVC Insulated 1.1 Kv Power Cables :

$$P = P_0 + CuF(Cu-Cu_0) + CCFCu(PVCC-PVCC_0) + FeF(Fe-Fe_0) + AIF(AI-AI_0)$$

For Steel armoured cables : $AIF=0$,

For Aluminium armoured cables : $FeF = 0$,

For Unarmoured cables , $FeF, AIF = 0$.

iii) Copper conductor PVC Insulated 1.1 Kv Control Cables :

$$P = P_0 + CuF(Cu-Cu_0) + CCFCu(PVCC-PVCC_0) + FeF(Fe-Fe_0)$$

For unarmoured cables $FeF=0$

iv) For Aluminium conductor XLPE Insulated 1.1 Kv Power Cables :

$$P = P_0 + AIF(AI-AI_0) + XLFAI(CC-CC_0) + CCFAl(CC-CC_0) + FeF(Fe - Fe_0)$$

For unarmoured multicore cables(without steel armour) $FeF=0$.

v) For Copper conductor XLPE Insulated 1.1 Kv Power Cables :

$$P = P_0 + CuF(Cu-Cu_0) + XLFCu(CC-CC_0) + CCFCu(CC-CC_0) + FeF(Fe - Fe_0) + AIF(AI-AI_0)$$

For Steel armoured cables : $AIF=0$,

For Aluminium armoured cables : $FeF = 0$,

For Unarmoured cables , $FeF, AIF = 0$.

vi) For Copper conductor XLPE Insulated 1.1 Kv Control Cables :

$$P = P_0 + CuF(Cu-Cu_0) + XLFCu(CC-CC_0) + CCFCu(CC-CC_0) + FeF(Fe - Fe_0)$$

For unarmoured cables $FeF=0$

Wherein,

P = Price payable as adjusted in accordance with the above appropriate formula in Rs per Km

P_0 = Price quoted/accepted for Cables in Rs per Km

Aluminium:

AIF= Variation factor for Aluminium applicable depending upon type and size of the cable.

Alo = Price of Aluminium

This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

Al = Price of Aluminium

This price is as applicable on the 1st working day of the month, one month prior to the date of delivery.

Copper:

CuF= Variation factor for Copper applicable depending upon type and size of the cable.

Cuo= Price of CC copper rods

This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

Cu= Price of CC copper rods

This price is as applicable on the 1st working day of the month, one month prior to the date of delivery.

PVC Compound:

CCFAI = Variation factor for PVC Compound/polymer for Aluminium cable.

CCFCu = Variation factor for PVC Compound/polymer for Copper cable.

PVCCo = Price of PVC Compound

This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

PVCC = Price of PVC Compound

This price is as applicable on the 1st working day of the month, two months prior to the date of delivery.

XLPE Compound:

XLFAI = Variation factor for XLPE Compound/polymer for Aluminium cable.

XLFCu = Variation factor for XLPE Compound/polymer for Copper cable.

CCo = Price of XLPE Compound

This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

CC = Price of XLPE Compound

This price is as applicable on the 1st working day of the month, two months prior to the date of delivery.

Steel:

FeF= Variation factor for Steel

Feo = Price of steel strips/steel wires

This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

Fe = Price of steel strips/steel wires

This price is as applicable on the 1st working day of the month, two months prior to the date of delivery.

The above prices and indices are published by IEEMA on every 1st working day of the month shall be used for calculation of the variation.

Variation factors AIF,CuF,CCFAI,CCFCu,XLFAI,XLFCu,FeF for various sizes and cores of cables can be referred from the standard tables published by IEEMA.

NOTE: Price variation for items other than Cables shall calculated as per the formula given in clause 3.2.1

Form EXP-2(b): EXPERIENCE IN KEY ACTIVITIES

(The following table shall be filled in for Contracts performed by the Bidder and each member of a JV)

Date: [insert day, month, year]
 Bidder's Legal name: [insert full name]
 JV Party Legal name: [insert full name]
 Subcontractor's Legal name: [insert full name]
 IFB No.:CMRL/Phase-II/SYS/C4-E&M-05/2022
 Page [insert page number] of [insert page number]

1. Key Activity No (1): [insert name of Key Activity]

[Fill out one (1) form per contracts performed by the Bidder (Single Firm)/ JV member/ Subcontractor in accordance with Section III, Evaluation and Qualification Criteria, Sub-Factor 2.4.2(b). The documents listed/ stated as required shall be submitted as attachments hereto.]

(i) Total Quantity of Key Activity under the Contract :

Contract with Similar Key Activities			
Item	Information		
Contract Identification	[insert contract name and number, if applicable]		
Award Date	[insert day, month, year, e.g., 15 June 2015]		
Completion Date	[insert day, month, year, e.g., 03 October 2017]		
Role in Contract [check the appropriate box]	Prime Contractor		Subcontractor <input type="checkbox"/>
	Single entity <input type="checkbox"/>	JV member <input type="checkbox"/>	
Total Contract Amount	[insert total contract amount and currency(ies)]	INR [insert Exchange rate and total contract amount in INR equivalent]	
Quantity (as applicable) performed under the Contract per year or part of the year [insert extent of participation indicating actual quantity of key activity successfully completed in the role performed]	Total Quantity in the Contract (i)	Percentage Participation (ii)	Actual Quantity Performed (i) x(ii)
Year 1			
Year 2			
Year 3			
Year 4			
Employer's Name:	[insert full name]		

Contract with Similar Key Activities	
Address:	<i>[indicate mailing address]</i>
Telephone/fax number	<i>[insert telephone/fax numbers, including country and city area codes]</i>
Email:	<i>[insert email address, if available]</i>
<p>Attached herewith are the copies of originals of:</p> <p>(a) abstracts of contract documents, sub-contract agreements, JV Agreements, etc. evidencing that the above activity meets the criteria specified in Section III, Evaluation and Qualification Criteria, Sub-Factor 2.4.2(b).</p> <p>(b) the end-user certificate(s) (i.e. Taking-over Certificate(s)/ Completion Certificate(s)) for the above-mentioned contract, evidencing that the above activity has been successfully carried out.</p>	

Key Activity No. (2):

Key Activity No. (3):



CHENNAI METRO RAIL LIMITED

CHENNAI METRO RAIL PROJECT PHASE 2, CORRIDOR 4 TENDER No. C4-E&M-05

Supply, installation, testing, commissioning and training of Electrical, Fire protection and VAC works for 18 Elevated stations from Power House Station to Poonamallee Bypass station including Viaduct between the stations (Ch 10027.102 to Ch 25928.186), approach ramp, including Poonamallee Depot for Corridor 4 of Chennai Metro Rail Project Phase-II

PART - 2

EMPLOYER'S REQUIREMENTS

MARCH 2022

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No																																																																																															
1.	Part 2 Section VI A Chapter 2 Page 137 of 1752	<p>2.5.8 KEY PERSONNEL : The Contractor's Staffing Proposal shall include as a minimum the following Key Personnel and Non-Key personnel:</p> <p>(i) Minimum Key personnel to be deployed as per Clause 1.1.1 of Eligibility and Qualification criteria which is part of technical evaluation:</p> <table border="1" data-bbox="557 517 1068 868"> <thead> <tr> <th>S.No.</th> <th>Position</th> <th>No of Key Personnel</th> <th>To be employed within the below mentioned period (Days) from the issue of LoA</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Project Manager</td> <td>1</td> <td>30</td> </tr> <tr> <td>2</td> <td>Construction Managers</td> <td>3</td> <td>60</td> </tr> <tr> <td>3</td> <td>Design Manager</td> <td>1</td> <td>30</td> </tr> <tr> <td>4</td> <td>Chief Interface Coordinator</td> <td>1</td> <td>90</td> </tr> <tr> <td>5</td> <td>Chief Quality Assurance & Control Manager</td> <td>1</td> <td>30</td> </tr> <tr> <td>6</td> <td>Chief OHS&E Manager</td> <td>1</td> <td>90</td> </tr> <tr> <td>7</td> <td>BIM Manager</td> <td>1</td> <td>60</td> </tr> </tbody> </table>	S.No.	Position	No of Key Personnel	To be employed within the below mentioned period (Days) from the issue of LoA	1	Project Manager	1	30	2	Construction Managers	3	60	3	Design Manager	1	30	4	Chief Interface Coordinator	1	90	5	Chief Quality Assurance & Control Manager	1	30	6	Chief OHS&E Manager	1	90	7	BIM Manager	1	60	<p>2.5.6 KEY PERSONNEL : The Contractor's Staffing Proposal shall include as a minimum the following Key Personnel and Non-Key personnel:</p> <p>(i) Minimum Key personnel to be deployed <u>and their Eligibility and Qualification</u></p> <table border="1" data-bbox="1189 517 1816 1347"> <thead> <tr> <th>No.</th> <th>Position</th> <th>Minimum Educational Qualification</th> <th>No. of Key Personnel Positions.</th> <th>Total Work Experience (Minimum number of years)</th> <th>Experience in Similar Positions (Minimum number of years)</th> <th>To be employed within the below mentioned period (Days) from the issue of LoA</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Project Manager</td> <td>B, E/B.Tech in Electrical / Mechanical Eng.</td> <td>1</td> <td>20</td> <td>10</td> <td>30</td> </tr> <tr> <td>2.</td> <td>Construction Managers</td> <td>B, E/B.Tech in Mechanical / Electrical and Electronics Eng.</td> <td>3</td> <td>15</td> <td>8</td> <td>60</td> </tr> <tr> <td>3.</td> <td>Design Manager</td> <td>B, E/B.Tech in Electrical and Electronics Eng.</td> <td>1</td> <td>15</td> <td>8</td> <td>60</td> </tr> <tr> <td>4.</td> <td>Chief Interface Coordinator</td> <td>B, E/B.Tech in Mechanical / Electrical and Electronics Eng.</td> <td>1</td> <td>15</td> <td>8</td> <td>90</td> </tr> <tr> <td>5.</td> <td>Chief Quality Assurance & Control Manager</td> <td>B, E/B.Tech in Mechanical / Electrical and Electronics Eng.</td> <td>1</td> <td>15</td> <td>10</td> <td>45</td> </tr> <tr> <td>6.</td> <td>Chief OHS&E Manager</td> <td>Graduate in Science / B.Tech in Any Engineering with PG or Diploma in Safety Engg from DOTE³ or CSP or Diploma in NEBOSH.</td> <td>1</td> <td>15</td> <td>10</td> <td>45</td> </tr> <tr> <td>7.</td> <td>BIM Manager</td> <td>B, E/B.Tech in Mechanical / Electrical and Electronics Eng.</td> <td>1</td> <td>10</td> <td>5</td> <td>60</td> </tr> <tr> <td colspan="3">Total No. of Key Personnel</td> <td>9</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	No.	Position	Minimum Educational Qualification	No. of Key Personnel Positions.	Total Work Experience (Minimum number of years)	Experience in Similar Positions (Minimum number of years)	To be employed within the below mentioned period (Days) from the issue of LoA	1.	Project Manager	B, E/B.Tech in Electrical / Mechanical Eng.	1	20	10	30	2.	Construction Managers	B, E/B.Tech in Mechanical / Electrical and Electronics Eng.	3	15	8	60	3.	Design Manager	B, E/B.Tech in Electrical and Electronics Eng.	1	15	8	60	4.	Chief Interface Coordinator	B, E/B.Tech in Mechanical / Electrical and Electronics Eng.	1	15	8	90	5.	Chief Quality Assurance & Control Manager	B, E/B.Tech in Mechanical / Electrical and Electronics Eng.	1	15	10	45	6.	Chief OHS&E Manager	Graduate in Science / B.Tech in Any Engineering with PG or Diploma in Safety Engg from DOTE ³ or CSP or Diploma in NEBOSH.	1	15	10	45	7.	BIM Manager	B, E/B.Tech in Mechanical / Electrical and Electronics Eng.	1	10	5	60	Total No. of Key Personnel			9				Amended as underlined
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SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
2.	Part 2 Section VI A Chapter 2 Page 139, 140 of 1752	<p>b. The Project Manager shall be authorized to represent the Contractor on all aspects under the Contract and shall bear overall responsibility for the management, coordination and progress of the Contract.</p> <p>Project Manager shall have relevant experience as per EQC Part-1,Section III, including experience in overall responsibilities for large-scale construction projects similar to the Works under this Contract.</p> <p>The proposed Project Manager shall hold a University Degree in Electrical or Mechanical Engineering or an equivalent qualification, appropriate to the nature of the work included in the Contract.</p> <p>The Project Manager must be bestowed with adequate authority to receive and carry out the directions and instructions from the Engineer. The Project Manager shall have a fluent command of written and spoken English and shall be employed fulltime on this site.</p> <p>c. The Construction Managers shall have relevant experience as per EQC, including experience in a key position on site for supervision or construction of large-scale Electrical and Mechanical works.</p> <p>d. The Design Managers shall have experience as per EQC including experience in design of large scale Electrification works similar to the Works under this contract.</p>	<p>b. The Project Manager shall be authorized to represent the Contractor on all aspects under the Contract and shall bear overall responsibility for the management, coordination and progress of the Contract.</p> <p>Project Manager shall have relevant experience as <u>mentioned above</u> including experience in overall responsibilities for large-scale construction projects similar to the Works under this Contract.</p> <p>The proposed Project Manager shall hold a University Degree in Electrical or Mechanical Engineering or an equivalent qualification, appropriate to the nature of the work included in the Contract.</p> <p>The Project Manager must be bestowed with adequate authority to receive and carry out the directions and instructions from the Engineer. The Project Manager shall have a fluent command of written and spoken English and shall be employed fulltime on this site.</p> <p>c. The Construction Managers shall have relevant experience as <u>mentioned above</u>, including experience in a key position on site for supervision or construction of large-scale Electrical and Mechanical works.</p> <p>d. The Design Managers shall have experience as <u>mentioned above</u> including experience in design of large scale Electrification works similar to the Works under this contract.</p>	Amended as underlined

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
		<p>e. The Chief Quality Assurance & Control Manager shall be with relevant years of experience as per EQC and as QA/QC Managers on similar size and type of construction projects, which shall have included work with the major trades which are expected in this Contract such as HVAC, Fire fighting, Electrification etc.</p> <p>f. Chief Interface Coordinator shall have a degree in Electrical/Mechanical engineering and have experience as per EQC including a minimum 8years of experience in interface co-ordination & Management of MEP works, traffic, utility diversion and all system wide works.</p> <p>g. The Chief OHS&E Manager shall be an experienced Engineer with relevant years' experience as per EQC and as per Table 2 of section VI-A, Volume 1–Control of Part 2. He shall be experienced in administering safety assurance programs for Electrical, HVAC and Fire safety. He shall be knowledgeable of, and have experience in, the development and application of ISO 9001 standards for Electrical and Mechanical works.</p>	<p>e. The Chief Quality Assurance & Control Manager shall be with relevant years of experience as <u>mentioned above</u> and as QA/QC Managers on similar size and type of construction projects, which shall have included work with the major trades which are expected in this Contract such as HVAC, Fire fighting, Electrification etc.</p> <p>f. Chief Interface Coordinator shall have a degree in Electrical/Mechanical engineering and have experience as <u>mentioned above</u> including a minimum 8years of experience in interface co-ordination & Management of MEP works, traffic, utility diversion and all system wide works.</p> <p>g. The Chief OHS&E Manager shall be an experienced Engineer with relevant years' experience as <u>mentioned above</u> and as per Table 2 of section VI-A, Volume 1–Control of Part 2. He shall be experienced in administering safety assurance programs for Electrical, HVAC and Fire safety. He shall be knowledgeable of, and have experience in, the development and application of ISO 9001 standards for Electrical and Mechanical works.</p>	
3.	Part 2 Section VI A Chapter 2 Page 140 of 1752	<p>m. The minimum Key Personnel and Non-Key personnel as listed in 2.5.8 above, if not employed/deployed on site within the time frame specified therein, a deduction shall be made for each month or part thereof for each Personnel / position not deployed, shall be as under:</p> <ul style="list-style-type: none"> • Project Manager – INR 10 Lakhs 	<p>m. The minimum Key Personnel and Non-Key personnel as listed in 2.5.8 above, if not employed/deployed on site within the time frame specified therein, a deduction shall be made for each month or part thereof for each Personnel / position not deployed, shall be as under:</p> <ul style="list-style-type: none"> • Project Manager – INR 10 Lakhs 	Amended as underlined

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query Sl. No
		<ul style="list-style-type: none"> • Chief QA/QC Managers and Chief OHSE managers – INR 5 Lakhs • Chief Interface coordinator, BIM Manager– INR 3 Lakhs • Engineering Manager (Design), Dy QA&QC Manager– INR 2 Lakhs • Engineer- MEP, Planning Engineer, Procurement Engineer, OHS&E Engineer- INR 1 Lakh 	<ul style="list-style-type: none"> • Chief QA/QC Managers, <u>Construction manager , Design Manager</u> and Chief OHSE managers – INR 5 Lakhs • Chief Interface coordinator, BIM Manager– INR 3 Lakhs • Engineering Manager (Design), Dy QA&QC Manager– INR 2 Lakhs • Engineer- MEP, Planning Engineer, Procurement Engineer, OHS&E Engineer- INR 1 Lakh 	
4.	Part 2 Section VI A Chapter 13 Page 248 of 1752	CHAPTER 13: BIM GUIDELINES	<u>Replaced Chapter 13 with the following:</u>	Added as Annexure-3
5.	Part 2 Section VI A Appendix 2 Page 340 to 352 of 1752	Appendix 2: Construction Interface Management Annexure-D Preliminary Interface sheets Annexure-E Master Interface Matrix	<u>Replaced Annexure-D and E with the following:</u>	Added as Annexure-4
6.	Part 2 Section VI A Appendix 6 Page 372 to 388 of 1752	Appendix 6: Approved Manufacturer/Supplier	<u>Replaced Appendix 6: with the following:</u>	Added as Annexure-5 Sl. No 117, 255, 256, 346, 347,
7.	Part 2 Section VI A Appendix 12 Page 450 of 1752		<u>New Chapter added under Section VI A Appendix 12 IS & cyber security technical requirements</u>	Added as Annexure-6

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query Sl. No																								
8.	Part 2 Section VI A Chapter 3 Page 157 of 1752	3.12 Design Verification and Validation Plan NOT USED	<u>3.12 Deleted</u>	Amended as underlined. Sl. No 299																								
9.	Part 2 Section VI A Chapter-19 Page 303 & 304 of 1752	f. Manpower deployment during DLP for EM-01 Contract package : <table border="1" data-bbox="456 619 1081 1391"> <thead> <tr> <th>S.No</th> <th>Position</th> <th>Minimum Qualification Criteria</th> <th>No of positions</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>DLP Supervising Manager</td> <td>Graduate in Electrical Engineering with minimum 12 years total experience and 5-year experience in the role of Electrical Maintenance works in Underground Metro Stations.</td> <td>1</td> </tr> <tr> <td>2</td> <td>DLP Supervising Engineer - Electrical</td> <td>Graduate in Electrical Engineering with minimum 5</td> <td>4</td> </tr> </tbody> </table>	S.No	Position	Minimum Qualification Criteria	No of positions	1	DLP Supervising Manager	Graduate in Electrical Engineering with minimum 12 years total experience and 5-year experience in the role of Electrical Maintenance works in Underground Metro Stations.	1	2	DLP Supervising Engineer - Electrical	Graduate in Electrical Engineering with minimum 5	4	f. Manpower deployment during DLP for <u>EM-05</u> Contract package: <table border="1" data-bbox="1122 619 1720 1391"> <thead> <tr> <th>S. No</th> <th>Position</th> <th>Minimum Qualification Criteria</th> <th>No of positions</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>DLP Supervising Manager</td> <td>Graduate in Electrical Engineering with minimum 12 years total experience and 5-year experience in the role of Electrical Maintenance works in <u>Elevated stations or Depot</u></td> <td>1</td> </tr> <tr> <td>2</td> <td>DLP Supervising Engineer - Electrical</td> <td>Graduate in Electrical Engineering with minimum 5</td> <td><u>1</u></td> </tr> </tbody> </table>	S. No	Position	Minimum Qualification Criteria	No of positions	1	DLP Supervising Manager	Graduate in Electrical Engineering with minimum 12 years total experience and 5-year experience in the role of Electrical Maintenance works in <u>Elevated stations or Depot</u>	1	2	DLP Supervising Engineer - Electrical	Graduate in Electrical Engineering with minimum 5	<u>1</u>	Amended as underlined. Sl. No 166, 167
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SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing				As Amended				Remarks / Pre-Bid Query SI. No	
				years total experience and 2-year experience in the role of Electrical Maintenance works in Underground Metro Stations or infrastructure projects			years total experience and 2-year experience in the role of Electrical Maintenance works in <u>Elevated stations</u> or <u>Depot</u> or infrastructure projects				
		3	DLP Supervising Engineer - Mechanical	Graduate in Mechanical Engineering with minimum 5 years total experience and 2-year experience in the role of Mechanical Maintenance works in Underground Metro Stations or infrastructure projects	4		3	DLP Supervising Engineer - Mechanical	Graduate in Mechanical Engineering with minimum 5 years total experience and 2-year experience in the role of Mechanical Maintenance works in <u>Elevated stations</u> or <u>Depot</u> or infrastructure projects	1	

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing				As Amended				Remarks / Pre-Bid Query SI. No		
		4	DLP Technicians	Diploma/ ITI holder with minimum 5 years total experience and 2-year experience in the role of Maintenance works	Based on maintenance calls		4	DLP Technicians	Diploma/ ITI holder with minimum 5 years total experience and 2-year experience in the role of Maintenance works	Based on maintenance calls		
10.	Part 2 Section VI A Chapter 2 Page 137 of 1752	2.5.8 KEY PERSONNEL Position - Chief OHS&E Manager No of Key Personnel – 1 To be employed within the below mentioned period (Days) from the issue of LoA - 90				2.5.8 KEY PERSONNEL Position - Chief OHS&E Manager No of Key Personnel – 1 To be employed within the below mentioned period (Days) from the issue of <u>LOA</u> - 30				Amended as underlined		
11.	Part 2 Section VI A Chapter 2 1.2.3.1 Page 1017 of 1752	Glanding plates, glanding brackets and extension boxes shall be removable and shall be of adequate size for the cables to be terminated. For single core cable termination, non-magnetic type of gland plate with adequate thickness (min 3.2mm) and supports shall be provided.				Glanding plates, glanding brackets and extension boxes shall be removable and shall be of adequate size for the cables to be terminated. For single core cable termination, non-magnetic type of gland plate with adequate thickness (<u>minimum 3mm</u>) and supports shall be provided.				Amended as underlined SI. No 190, 439		
12.	Part 2 Section VI C, Specification Clause No - 1.2.3.6 Page 1026 of 1752	The cubicle section shall be constructed of angle iron type frames / Galvanized Iron frame with Multi fold (min 6fold) structure and bolted/modular construction with all necessary removable covers.				The cubicle section shall be constructed of angle iron type frames / Galvanized Iron frame with Multi fold (<u>minimum 6-fold / as per OEM type tested design</u>) structure and bolted/modular construction with all necessary removable covers.				Amended as underlined SI. No 191, 440		
13.	Part 2 Section VI	Gland plates of not less than 3.2mm thick with bracing of suitable size shall be provided at the top and bottom				Gland plates of not less than <u>3mm</u> thick with bracing of suitable size shall be provided at the top and bottom of the LV main				Amended as underlined		

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
	C, Specification Clause No - 1.2.3.6 Page 1027 of 1752	of the LV main switchboards for the termination of incoming and outgoing power cables or busways.	switchboards for the termination of incoming and outgoing power cables or busways.	SI. No 290
14.	Part 2 Section VI C, Specification Clause No - 1.2.3.9 Page No 1031 of 1752	The maximum temperature rise of the busbars and the bus connections shall not exceed 85°C.	<u>The ambient temperature and relative humidity for Electrical Panel shall be as per clause 1.12.3.1 Environmental conditions. Temperature rise limit report shall be provided as per IEC 61439 part 1& 2 and the maximum temperature of the bus bars and the bus connections shall be 90°C.</u>	Amended as underlined SI. No 197
15.	Part 2 Section VI C, Specification Clause No - 1.2.3.13 Page No 1032 of 1752	All internal and control wiring shall be Fire Retardant Low Smoke Halogen (FRLSH) flexible stranded copper conductor wires rated at 1100 V complying with BS 6724/IEC 60502.	All internal and control wiring shall be <u>Flame</u> Retardant Low Smoke Halogen (FRLSH) flexible stranded copper conductor wires rated at 1100 V complying with <u>IS 694</u> .	Amended as underlined
16.	Part 2 Section VI C, Specification Clause No - 1.2.3.16 Page No 1034 of 1752	c. PQM shall sample continuously at 256 samples per cycle along with monitoring individual harmonics up to 51 st . PQM shall have Waveform capture, detection of voltage swells and sags & Disturbance Direction detection features	c. PQM shall sample continuously at <u>128</u> samples per cycle along with monitoring individual harmonics up to 51 st . PQM shall have Waveform capture, detection of voltage swells and sags & Disturbance Direction detection features	Amended as underlined SI. No 413

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No				
17.	Part 2 Section VI C, Specification Clause No - 1.2.6 Page No 1053 of 1752	Miniature Circuit Breakers (MCB) • Class 3 with range of instantaneous tripping current C or D type as appropriate or as specified,	Miniature Circuit Breakers (MCB) • Class 3 with range of instantaneous tripping current <u>shall be as tabulated or as specified</u> <table border="1" data-bbox="1176 464 1711 651"> <tr> <td>Type-C</td> <td><u>Lighting, Signage, General purpose & advertisement sockets</u></td> </tr> <tr> <td>Type-D</td> <td><u>UPS Circuits</u></td> </tr> </table>	Type-C	<u>Lighting, Signage, General purpose & advertisement sockets</u>	Type-D	<u>UPS Circuits</u>	Amended as underlined SI. No 185
Type-C	<u>Lighting, Signage, General purpose & advertisement sockets</u>							
Type-D	<u>UPS Circuits</u>							
18.	Part 2 Section VI C, Specification Clause No - 1.2.7 Page No 1054 of 1752	Residual Current Circuit Breaker RCCBs shall be double pole or four-pole current-operated, housed in a totally enclosed moulded case, manufactured and tested in compliance with IEC 61008 or EN 61008.	Residual Current Circuit Breaker RCCBs shall be <u>Type A</u> , double pole, or four-pole current-operated, housed in a totally enclosed moulded case, <u>manufactured</u> , and tested in compliance with IEC 61008 or EN 61008.	Amended as underlined SI. No 186				
19.	Part 2 Section VI C, Specification Clause No - 1.2.16 Page No 1090 of 1752		New Clause added under 1.2 <u>1.2.16 Active Harmonic Filter System (AHF)</u>	Added as Annexure-7				
20.	Part 2 Section VI C, Specification Clause No - 1.2.14.4.1	Mechanically Held Transfer Switch a) The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a single solenoid/motorized mechanism, monetarily energized in the event of normal supply failure, and	Mechanically Held Transfer Switch a) The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a single solenoid/motorized mechanism, monetarily energized in the event of normal supply failure, and can also be operated	Amended as underlined SI. No 226				

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query Sl. No
	Page No 1085 of 1752	can also be operated manually (on load) in the event of control circuit failure. The switch shall be mechanically interlocked to only three possible positions i.e., normal, emergency or Isolation.	manually (on load) in the event of control circuit failure. The switch shall be mechanically interlocked to only three possible positions i.e., <u>normal, emergency & Isolation.</u>	
21.	Part 2 Section VI C, Specification Clause No - 1.4.6 Page 1096 of 1752	The Fire Survival cables as per BS 7846 and BS 6387 shall be provided with minimum three layers of Glass mica tapes over the conductor with a minimum 25% overlapping of individual tapes and thickness of Glass mica tape shall not be less than 0.1 mm	The Fire Survival cables as per BS 7846 and BS 6387 shall be provided with minimum three layers of Glass mica tapes (<u>2 layers over the conductor and 1 layer over the insulation</u>) with a minimum 25% overlapping of individual tapes and thickness of Glass mica tape shall not be less than 0.1 mm	Amended as underlined Sl. No 437
22.	Part 2 Section VI C, Specification Clause No - 1.4.18.2 Page No 1102 of 1752	The terminating kits shall be suitable for termination of the cables on an indoor switchgear or equipment. These shall be of proven design and shall be type-tested as per relevant Indian or International Standards. Type test certificates shall be submitted. The cable and wire terminations shall avoid any possibility of loose joint and wire snapping. Cable conductor termination shall be by means of a heavy-duty solder less cable lug. The lug shall be of high conductivity copper, electro-tinned and applied to the conductor by means of a hydraulic crimping tool. All such crimping should meet the requirements of BS 4579/BS 61238.	The terminating kits shall be suitable for termination of the cables on an indoor switchgear or equipment. These shall be of proven design and shall be type-tested as per relevant Indian or International Standards. Type test certificates shall be submitted. The cable and wire terminations shall avoid any possibility of loose joint and wire snapping. Cable conductor termination shall be by means of a heavy-duty solder less cable lug. The lug shall be of high conductivity <u>electro-tinned copper / Aluminium /bimetallic and</u> applied to the conductor by means of a hydraulic crimping tool. All such crimping should meet the requirements of BS 4579/BS 61238.	Amended as underlined Sl. No 406
23.	Part 2 Section VI C, Specification Clause No - 1.4.18.3	<ul style="list-style-type: none"> The cable glands shall also be duly tested for dust proof and weatherproof termination. 	<ul style="list-style-type: none"> The cable glands shall also be duly tested for Dustproof and weatherproof termination for <u>Non. FS cables and IP-65 rated terminations in Wet areas and Outdoor areas. Flame proof glands shall be provided for FS cable terminations.</u> Cables lugs shall be tinned copper / Aluminium / bimetallic compression lug as Required. Lugs shall be solder less 	Amended as underlined Sl. No 134, 135

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
	Page No 1103 of 1752	<ul style="list-style-type: none"> Cables lugs shall be tinned copper solder less crimping type conforming to IS: 8309 and 8394 suitable for aluminium or copper conductor (as applicable). 	crimping type conforming to IS: 8309 and 8394 suitable for aluminium or copper conductor (as applicable).	
24.	Part 2 Section VI C, Specification Clause No - 1.5.3.2.2 Page No 1108 of 1752	All cable tray sizes upto 300mm shall be of standard configuration and 300 mm & above shall be of heavy-duty type with return flange.	All cable tray sizes <u>up to 450mm</u> shall be of standard configuration and <u>450 mm</u> & above shall be of heavy-duty type with return flange.	Amended as underlined SI. No 382
25.	Part 2 Section VI C, Specification Clause No - 1.6.4.1 Page 1130 of 1752	Every switch controlling an appliance shall be labelled with the name of the appliance it controls and shall be fitted with a 0.5 W neon indicating lamp.	Every switch controlling an appliance shall be labelled with the name of the appliance it controls and shall be fitted with a 0.5 W neon <u>or LED</u> indicating lamp.	Amended as underlined SI. No 150
26.	Part 2 Section VI C, Specification Clause No - 1.7.9.4.4 Page No 1147 of 1752	The system shall allow unlimited switching configurations. Any number of switches shall be able to program for 33%,66% and 100%loading (i.e., multi-way switching) and all switches shall indicate the load status.	The system shall allow unlimited switching configurations. Any number of switches shall be able to program for <u>25%, 50%, 75%</u> and 100% loading (i.e., multi-way switching) and all switches shall indicate the load status.	Amended as underlined SI. No 371
27.	Part 2 Section VI C,	Building Automation multi-protocol gateway	Building Automation multi-protocol gateway	Amended as underlined

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
	Specification Clause No 1.7.9.5.3 Page No 1148 of 1752	The Building Automation multi-protocol Gateway is based on the 12 M wide Building Automation multi-protocol rail enclosures, and shall be available in 110/120Vac and 220/240Vac ratings, 50Hz operation.	The Building Automation multi-protocol Gateway is based on the <u>3 Module - 12 Module</u> wide. Building Automation multi-protocol rail enclosures and shall be available in 110/120Vac and 220/240Vac ratings, 50Hz operation.	
28.	Part 2 Section VI C, Specification Clause No - 1.8.3.1 Page No 1151 of 1752	The foundation work shall be done by the Civil works Contractor as per the approved drawing. The pole with its base plate shall be grouted in the foundation which shall be provided with muffing.	The foundation work shall be done by the Contractor as per the approved drawing. The pole with its base plate shall be grouted in the foundation which shall be provided with muffing.	As Amended SI. No 152
29.	Part 2 Section VI C, Specification Clause No - 1.10.9 Page 1166 of 1752	Risers The Copper earth riser cables shall be brought from earthmat up to the MET as shown in the drawings. At each earth riser cable entry shall be through a HDPE sleeve with required as shown in the drawings. Earth riser cable shall be Single core FRLSH PVC insulated flexible copper conductor as per IS 7098.	Risers The Copper earth riser cables shall be brought from <u>earth mat</u> up to the MET as shown in the drawings. At each earth riser cable entry shall be through a HDPE sleeve with required as shown in the drawings. Earth riser cable shall be Single core <u>XLPE insulated, PVC Sheathed</u> flexible copper conductor as per IS 7098.	Amended as Underlined
30.	Part 2 Section VI C, Specification Page 1181 to 1226 of 1752	1.12 Uninterruptible Power Supply	<u>Replaced 1.12 Uninterruptible Power Supply with the following:</u>	Added as Annexure-8 SI. No 50, 51, 154, 273, 274, 445
31.	Part 2 Section VI	Temperature rise at any point in the bus duct shall not exceed 55°C over ambient temperature of 50°C and	<u>The ambient temperature and relative humidity for Busduct shall be as per clause 1.12.3.1 Environmental conditions.</u>	Amended as underlined

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
	C, Specification Clause No - 1.13.1 1227 of 1752	shall comply with latest edition of IEC-61439-1 & 6-2011 as amended/modified till date.	Temperature rise limit report shall be provided as per IEC 61439 part 1 & 2 for each busduct components as specified in IEC.	SI. No 209
32.	Part 2 Section VI C, Specification Clause No - 1.14.18.7 Page 1247 of 1752	The alternator shall be capable of continuous operation with a phase current imbalance of 33% of rated current	The alternator shall be capable of continuous operation with a phase current imbalance <u>as per IS Code/OEM recommendation.</u>	Amended as underlined SI. No 33
33.	Part 2 Section VI C, Specification Clause No - 1.14.40 Page 1265 of 1752	1.14.40 Technical datasheet for DG Set 3.1 Day tank: 10 Hrs of operation at full load supply, overflow, drain, filter and gauge glass etc.	1.14.40 Technical datasheet for DG Set 3.1 Day tank: <u>Minimum of 850 Litres or as per CPWD norms.</u>	Amended as underlined
34.	Part 2 Section VI C, Specification Clause No - 1.14.40 Page 1266 of 1752	1.14.40 Technical datasheet for DG Set 4.0 Acoustic Enclosure A) AIR CIRCULATION SYSTEM - If required as per CPCB norms. Type - Axial Flow Fan RPM - 1440/2800RPM B) Air Exhaust System Type - Axial Flow Fan Make - Reputed Make	1.14.40 Technical datasheet for DG Set 4.0 Acoustic Enclosure A) AIR CIRCULATION SYSTEM - If required as per CPCB norms. <u>Deleted</u> B) <u>Deleted</u>	Amended as underlined SI. No 42, 43

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
		<p>Speed - 1400/2800 RPM Quantity - 1 No. For Air Exhaust AIR SCREEN - For Radiator Exhaust INSULTED HOOD - At Canopy top Canopy Air Exhaust SILENCER HOOD INTAKE Type - Air Intake Hood Qty - 2 Nos. Design - With Acoustic Splitter & Baffles Insulated Hood Cover</p>		
35.	<p>Part 2 Section VIC Sub Section 2 Clause 2.4.9.1 Page 1286 & 1287 of 1752</p>	<p>2.4.9.1 The engine cooling system shall be included as part of the engine assembly and shall be of heat exchanger type that includes circulating pump driven by the engine, a heat exchanger, and an engine jacket temperature regulating device.</p> <p>2.4.9.2 Coolant and Fill Openings: An opening shall be provided in the circuit for filling the system, checking coolant level, and adding make-up coolant when required. The coolant shall comply with the recommendation of the engine Manufacturer.</p> <p>2.4.9.3 A heat exchanger cooling loop according to NFPA 20 shall be supplied with the engine with a heat resistant flexible connection to the engine.</p> <p>2.4.9.4 The cooling water supply shall be from the discharge of the pump taken off prior to the pump discharge check valve. Threaded rigid piping shall be used for this connection. The pipe connection in the direction of flow shall include an indicating manual</p>	<p>2.4.9.1 The engine cooling system shall be included as part of the engine assembly and <u>shall be radiator water cooled. The radiator assembly shall be mounted on the engine. The radiator fan shall be driven by the engine as its auxiliary with multiple fan belts. When half the belts are broken, the remaining belts shall be capable of driving the fan. Cooling water shall be circulated by means of an auxiliary pump of suitable capacity driven by the engine in a closed circuit.</u></p> <p><u>2.4.9.2 Deleted</u></p> <p><u>2.4.9.3 Deleted</u></p> <p><u>2.4.9.4 Deleted</u></p> <p><u>2.4.9.5 Deleted</u></p> <p><u>2.4.9.6 Deleted</u></p> <p><u>2.4.9.7 Deleted</u></p>	<p>Amended as Underlined SI. No 140,</p>

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
		<p>shutoff valve, an approved flushing-type strainer in addition to the one that can be a part of the pressure regulator, a pressure regulator, an automatic valve, and manual shutoff valve. A pressure gauge shall be installed in the cooling water supply system on the engine side of the last manual valve.</p> <p>2.4.9.5 Pressure Regulator: The sizing of pressure regulator shall be as per recommendations of Manufacturer but under any condition it shall be of such size and type that it is capable of and adjusted for passing approximately 120 percent of the cooling water required when the engine is operating at maximum brake horsepower and when the regulator is supplied with water at the pressure of the pump when it is pumping at 150 percent of its rated capacity. The cooling water flow required shall be set based on the maximum ambient cooling water.</p> <p>2.4.9.6 Automatic Valve. Provision of automatic valve shall be made on supply line to permit flow of cooling water to the engine when it is runninC.</p> <p>2.4.9.7 Bypass connection: A bypass line with manual valves, a flush type strainer, and a pressure regulator shall be installed around the manual shutoff valve, strainer, pressure regulator, and automatic valve.</p> <p>2.4.9.8 Waste Outlet; An outlet shall be provided for the wastewater line from the heat exchanger, and the discharge line shall be one size larger than the inlet line. The outlet line shall be as short as possible, shall</p>	<p><u>2.4.9.8 Deleted</u></p>	

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
		provide discharge into a visible open waste cone, and shall have no valves in it.		
36.	Part 2 Section VIC Sub Section 2 Clause 2.5.7.1 Page 1291 and 1292 of 1752	2.5.7.1 First Aid Hose Reel is meant for delivering small quantity of water in early stage of fire and can be operated even by untrained personnel, and thus provides a most effective firefighting facility. It shall be directly tapped from the riser through a 20mm dia pipe with isolation valve. It consists of a 30m length with 20 mm (nominal internal) diameter hose tubing wrapped around a reel with water inlet pipe, stop valve and shut off nozzle. The entire assembly is mounted on a MS wall bracket and can swing 180 degree. The hose tube can be pulled out easily for the purpose of discharge of water on fire.	2.5.7.1 First Aid <u>Fire</u> Hose Reel is meant for delivering small quantity of water in early stage of fire and can be operated even by untrained personnel, and thus provides a most effective firefighting facility. It shall be directly tapped from the riser through a <u>25mm diameter</u> pipe with isolation valve. It consists of a 30m length with <u>25 mm</u> (nominal internal) diameter hose tubing wrapped around a reel with water inlet pipe, stop valve and shut off nozzle. The entire assembly is mounted on a MS wall bracket and can swing 180 degrees. The hose tube can be pulled out easily for the purpose of discharge of water on fire.	Amended as underlined. SI. No 260
37.	Part 2 Section VIC Sub Section 2 Clause 2.6.8 Page 1296 of 1752		New Clause added under 2.6 <u>2.6.8 Pre-Action Systems</u>	Added as Annexure-9
38.	Part 2 Section VIC Sub Section 2 Page 1312 of 1752	2.8.21 Metallic Expansion bellows (UL/FM Approved) 2.8.21.1 The Expansion Bellows shall be Screwed to BSP Female Threads as per FM approved from 15mm- 40mm and Flanged to Table E from 50mm-300mm PN 16 and ANSI 150 # for PN 25 expansion joints. Screwed Connection shall be Female/ Male Threaded on a Forged Brass Body and Flanges shall be non- compressible and mechanically strong Made of M.S With Electrofusion Epoxy Coating Paint and	2.8.21 Metallic Expansion bellows (<u>As per IS</u>) 2.8.21.1 The Expansion Bellows shall be Screwed to BSP Female Threads as per <u>IS-554</u> from 15mm- 40mm and Flanged to Table E from 50mm- 300mm PN 16 and ANSI 150 # for PN 25 expansion joints. Screwed Connection shall be Female/ Male Threaded on a Forged Brass Body and Flanges shall be non-compressible and mechanically strong Made of M.S With Electrofusion Epoxy Coating Paint and Stainless Steel AISI 321 Corrugated Flexible hose with AISI 304 Single Braided Steel	Amended as underlined. SI. No 257

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
		Stainless Steel AISI 321 Corrugated Flexible hose with AISI 304 Single Braided Steel Overbraid for PN 16 and Double Overbraid for PN 25 provided in between the flanged or Screwed ends. The Bellow shall work for a temperature range of 10°C to 70°C.	<u>Over braid</u> for PN 16 and <u>Double Over braid</u> for PN 25 provided in between the flanged or Screwed ends. The Bellow shall work for a temperature range of 10°C to 70°C.	
39.	Part 2 Section VIC Sub Section 2 Page 1325 of 1752	2.12.2.1. CO2 type Fire Extinguisher of 4.5Kgs. Capacity, made from brand new seamless cylinder, as per IS: 7285, fitted with hose and horn and Squeeze Grip Valve with initial Charge of CO2 Gas conforming to IS 15222 and Extinguisher as per BIS:15683:2006 specification with ISI Mark along with mounting Bracket and PESO certificate for cylinders	2.12.2.1. CO2 type Fire Extinguisher of 4.5Kgs. Capacity, made from brand new seamless cylinder, as per IS: 7285, fitted with hose and horn and Squeeze Grip Valve with initial Charge of CO2 Gas conforming to IS 15222 and Extinguisher as per BIS:15683:2018 specification with ISI Mark along with mounting Bracket and PESO certificate for cylinders	Amended as underlined. SI. No 263
40.	Part 1 Section VI C Sub Section 2 Page 1352 of 1752	Aspiration Smoke Detection	New Clause added under 2.13 <u>2.13.8.14</u>	Added as Annexure-10 SI. No 348
41.	Part 1 Section VI C Sub Section 2 Page 1333 of 1752	2.13.12. The system shall be an intelligent addressable fire alarm and detection system. NFPA 130-2020 (latest edition) shall be used as the guiding standard for the fire alarm and detection system. The system shall be designed in an integrated manner in accordance with NFPA-72, 2016 Edition, as appropriate or other internationally recognized and local code of practice.	2.13.12. The system shall be an intelligent addressable fire alarm and detection system. NFPA 130- <u>2022</u> (latest edition) shall be used as the guiding standard for the fire alarm and detection system. The system shall be designed in an integrated manner in accordance with NFPA-72, <u>2022</u> Edition <u>or latest</u> , as appropriate, or other internationally recognized and local code of practice.	Amended as underlined.
42.	Part 1 Section VI C	2.13.5.2 Codes and regulations of the jurisdictional authorities	2.13.5.2 Codes and regulations of the jurisdictional authorities NFPA 72 <u>2022</u> National Fire Alarm and <u>Signalling</u> Code	Amended as underlined.

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
	Sub Section 2 Page 1336 of 1752	NFPA 72 2016 National Fire Alarm and Signaling Code		
43.	Part 1 Section VI C Sub Section 2 Page 1351 of 1752	2.13.8.13 Programmable Directional Sounders a. Shall follow NFPA 72 2019 edition Clause 18.4.8.	2.13.8.13 Programmable Directional Sounders a. Shall follow NFPA 72 <u>2022</u> edition Clause 18.4.8.	Amended as underlined.
44.	Part 1 Section VI C Sub Section 3 3.8.4.1. ff Page 1471 of 1752	Sound power level shall not exceed 50 dBA measured 1m from the fan	Sound power level shall not exceed <u>65-70</u> dBA measured 1m from the fan	Amended as underlined. SI. No 174
45.	Part 1 Section VI C Sub Section 3 3.8.4.6.j Page 1478 of 1752	Fan sound power when measured at 1m distance shall not exceed 55 dBA	Fan sound power when measured at 1m distance shall not exceed <u>65-70</u> dBA	Amended as underlined. SI. No175
46.	Part 1 Section VI C Sub Section 3 3.15.1 Page 1509 of 1752	3.15.1 CO2 Sensor a) High sensitivity and selectivity to Carbon di oxide b) Detect range: 0 – 40000ppm c) Output: 4-20mA / 2-10 VDC d) Accuracy: ± (30 ppm) e) Response Time : 20 seconds f) Operating temperature: -10 to 50 Deg C.	3.15.1 CO2 Sensor a) High sensitivity and selectivity to Carbon di oxide b) Detect range: 0 – <u>2000 ppm</u> c) Output: 4-20mA d) Accuracy: ± (30 ppm) e) Response Time: 20 seconds Operating temperature: -10 to 50 Deg C.	Amended as underlined.

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query Sl. No
47.	Part 2 Section VI C, Specification Clause No - 4.1 Page No 1523 of 1752	Technical Requirements The supply shall comprise stationary type, electric motor driven, oil free noiseless screw type complete with suction filter, air/oil separator, air cooled after cooler, oil filter, oil cooler integrated refrigerated air drier & moisture trap, microprocessor-based control panel all housed in silenced package provided on anti-vibration mounts. The supply shall include air reservoirs (02 nos), air filters, pipes and pipe couplings, electric controls, and all other accessories to make the equipment & installation fully functional.	Technical Requirements The supply shall comprise stationary type, electric motor driven, noiseless screw type complete with suction filter, air/oil separator, air cooled after cooler, oil filter, oil cooler refrigerated air drier & moisture trap, microprocessor-based control panel all housed in silenced package provided on anti-vibration mounts <u>to supply Oil Free air</u> . The supply shall include <u>air reservoir</u> , air filters, pipes and pipe couplings, electric controls, and all other accessories to make the equipment & installation fully functional.	Amended as underlined. Sl. No 159
48.	Part 2 Section VI C, Specification Clause No - 4.3b Page No 1524 of 1752	b, Compressor Single stage self-lubricated rotary screw compressor having high efficiency and reliability shall be provided	b, Compressor Single stage <u>lubricated</u> rotary screw compressor having high efficiency and reliability shall be provided	Amended as underlined. Sl. No 159
49.	Part 2 Section VI C, Specification Clause No - 4.3g Page No 1525 of 1752	g, Air dryer The compressor shall have an integrated air-cooled type refrigerant dryer in the downstream of the compressor within the same canopy & the design shall make the installation more compact	g, Air dryer The compressor set shall have an <u>air-cooled type refrigerant dryer in the downstream of the Reservoir</u> within the same canopy & the design shall make the installation more compact.	Amended as underlined. Sl. No 158, 244

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
50.	Part 2 Section VI C, Specification Clause No - 4.3h Page 1526 of 1752	h, Reservoir The Contractor shall install two numbers of approx. 1500 litres reservoirs in an area downstream of the dryers	h, Reservoir The Contractor shall install <u>approx. 1000 litres reservoirs in an area downstream of the compressor.</u>	Amended as underlined. SI. No 245
51.	Part 1 Section VI C Sub Section 2 Page 1538 of 1752	5.1.5.1 NFPA 130: 2020 or latest standard- Fixed Guideway Transit Systems: any non-compliance shall be approved in writing by the CMRL.	5.1.5.1 NFPA 130: <u>2022</u> or latest standard- Fixed Guideway Transit Systems: any non-compliance shall be approved in writing by the CMRL.	Amended as underlined
52.	Part 1 Section VI C Sub Section 5 Clause 5.6.1.6 Page 1552 of 1752	The equipment shall also have arrangements to log and record various parameters on a regular basis and store the results for at least six months. The contractor shall also provide portable equipment such as Notebook, PCs for extracting information from the logic at the digital control equipment and then store for any future use for maintenance or planninC.	The equipment shall also have arrangements to log and record various parameters on a regular basis and store the results for at least six months. <u>It shall have capability of</u> extracting information from the logic at the digital control equipment and then store for any future use for maintenance or planning.	Amended as underlined. SI. No 281

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
53.	Part 1 Section VI C Sub Section 5 Clause 5.7.5.1 Page 1556 of 1752	5.7.5.1 WIND VELOCITY Sensor: Wind Speed Sensor is designed with rugged components stand up to hurricane-force wind yet is sensitive to a light breeze. It includes sealed bearings for long life. The range and accuracy specifications have been verified in wind tests. In areas where icing of the anemometer is a problem, drip rings deflect water from the joint between moving parts. Supply, Installation, Testing & Commissioning of sensor's mentioned with all the mounting accessories included. The sensor shall be Infra-Red type with 4 to 20 mA transmitter. The measurement range shall be -20 to +20 m/s, accuracy $\pm 1\%$, start-up wind speed should be 0.5 m/s. The Sensor Interface Module converts standard sensor outputs into formats suitable for long distance transmission (4 - 20 mA, RS 232, RS 485)	5.7.5.1 WIND VELOCITY Sensor: Wind Speed Sensor is designed with rugged components stand up to hurricane-force wind (<u>in the range of 40 m/s</u>) yet is sensitive to a light breeze. It includes sealed bearings for long life. The range and accuracy specifications have been verified in wind tests. Supply, Installation, Testing & Commissioning of sensor's mentioned with all the mounting accessories included. The sensor shall be Infra-Red type with 4 to 20 mA transmitter. The measurement range shall be -20 to +20 m/s, accuracy $\pm 1\%$, start-up wind speed should be 0.5 m/s. The Sensor Interface Module converts standard sensor outputs into formats suitable for long distance transmission (4 - 20 mA, RS 232, RS 485)	Amended as underlined.
54.	Part 1 Section VI C Sub Section 5 Clause 5.7.4.2.6.2 Page 1559 of 1752	Note: The PLC must operate at the nominal supply frequency of 50 Hz with a 15 % variation. The PLC must have at the IP 54 protection. PLC can be increase or decrease as per functional and operational requirements. Contractor is bounded to provided fully functional M&E SCADA. Employer can demand separate SIL2 level PLC for VAC system if required due to functional requirement.	Note: The PLC must operate at the nominal supply frequency of 50 Hz with a 15 % variation. The PLC must have at the IP 54 protection. PLC can be increase or decrease as per functional and operational requirements. Contractor is bounded to provided fully functional M&E SCADA.	As Amended SI. No 282
55.	Part 1 Section VI C Sub Section 5 Page 1577 of 1752	PLC	New Class added under 5.11 <u>5.11.14</u>	Added as Annexure-11

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks / Pre-Bid Query SI. No
56.	Part 1 Section VI C Sub Section 5 Page 1594 of 1752	Workstation	New Clause added under 5 <u>5.20, 5.21, 5.22</u>	Added as Annexure-12 SI. No 344
57.	Part 1 Section VI D Page 1595 of 1752	Tender Drawings	Set of drawings (New and Revised) are added to Addendum-1. New and Revised Drawings can be downloaded from the following link: C4 EM05 -Addendum Drawings	Added as Annexure-13 SI. No 74, 95, 102,132, 240, 262, 271,272, 280, 285, 314,318, 349, 366, 367, 368, 369, 381, 385, 387 to 390, 446 to 449, 453 to 456



CHENNAI METRO RAIL LIMITED

CHENNAI METRO RAIL PROJECT PHASE 2 CORRIDOR 4

TENDER No. C4-E&M-05

Supply, installation, testing commissioning and training of Electrical, Fire protection and VAC works for 18 Elevated stations from Power House Station to Poonamallee Bypass station including Viaduct between the stations (Ch 10027.102 to Ch 25928.186), approach ramp, including Poonamallee Depot for Corridor 4 of Chennai Metro Rail Project Phase-II

PART - 2

EMPLOYER'S REQUIREMENTS

SECTION VIA – GENERAL SPECIFICATIONS

CHAPTER 13: BIM GUIDELINES

MARCH 2022

Chapter 13

BIM GUIDELINES & INFORMATION REQUIREMENTS

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1. BIM (Building Information Modelling)

1.1. Introduction

1.1.1 The purpose of this document (“Building Information Modelling (BIM) Guidelines and Information Requirements (Construction / Procurement)”) is to define the minimum requirements on BIM use to be achieved by the Contractor on the Project including associated parties.

1.1.2 Project Parties involved in fulfilling the BIM Objectives/Deliverables:

- (1) Detailed Design Consultants (DDCs) appointed by Employer - Works covering Architectural, Civil, Structural, MEP, Firefighting & Fire protection, Tracks, Via ducts, VAC & allied Building Services
- (2) Systems Wide Contractors (SWCs) covering MEP, VAC, Signaling, Telecommunications, PSD, Traction-OHE & Power, AFC, rolling stock, Depot equipment, workshops & OCC / BCC, BMS & SCADA, etc. works
- (3) Civil Contractors - Construction Works covering Architectural, Civil, Structural, Tracks, MMI, etc. for stations, viaduct, depot and allied facilities, ramps, etc.
- (4) Employer/Engineer
- (5) Any Other Stakeholders / Interfacing Contractors appointed or designated by Employer

1.1.3 The Detailed Design Consultant (DDC) appointed by EMPLOYER shall develop, and handover a Building Information Model (BIM) for the works covering Architectural, Civil, Structural, MEP, Tracks, VAC with a level of LOD 300.

1.1.4 The Contractor (acting as partner/Civil Contractor as lead) shall develop, BIM Model from level of LOD 300 to LOD 500 (As Built) as required in their scope of work.

1.1.5 The System Wide Contractor shall interface with the Civil Contractors, Nominated Subs (if any), and any other subcontractors, to obtain all necessary drawings, sketches, BIM services, models and other BIM related deliverables / information.

The Contractor shall be interface with the Railways System Wide Contractors (SWCs), Nominated Subs (if any), and any other subcontractors (if any), to integrate all BIM information into the As-Built Asset Model / Asset information Model (ABAM / AIM) and ensure its accuracy and consistency. Maintain, update and handover a Building Information Model (BIM) for the works with a level of LOD 500 (As Built).

1.1.6 By defining this common format for the preparation and presentation of BIM models, the exchange of information will improve and consequently maximise the use of BIM in the construction phase.

1.1.7 BIM Requirements (Construction / Procurement) shall include modelling, visualization, documentation, coordination, and the collaborative use of these

models throughout the project delivery as defined in this document.

- 1.1.8 In addition, the BIM Requirements (Construction / Procurement) is defined to support the asset management framework of the Employer. Employer shall request from the Contractor the BIM guidelines and associated standards to adopt and incorporate As-Built complaint models.

1.2. General

- 1.2.1 This document applies to BIM models developed during the construction stage, prior to handover.
- 1.2.2 All BIM models and drawings from feasibility stage shall become the reference points for the Employer / Engineer.
- 1.2.3 The BIM Requirements (Construction / Procurement) is written with reference to current associated standards (e.g.) BS EN ISO 19650, BS 1192, and PAS 1192 Standards and the BIM Requirements (Design), for the purpose of completeness of requirements. In the event of any inconsistency between the BIM Requirements (Construction / Procurement), BIM Requirements (Design) and BS EN ISO 19650, BS 1192, and PAS 1192 Standards and 2019 Version BIM Forum LOD Specification (AIA Standards), BIM Requirements (Construction / Procurement) will prevail, unless otherwise specified by the Employer/Engineer.
- 1.2.4 2D CAD submissions (Extracted from 3D BIM Model only) shall continue to adhere to the standards and comply with the approved BIM guidelines. All drawings for submission to Engineers and other authorities shall be prepared in accordance with these requirements and CAD requirements specified in General Specification.

1.3. BIM Execution Plan

- 1.3.1 The purpose of the BIM Execution Plan is to outline the plan and processes in which BIM will be implemented throughout the project lifecycle to meet the BIM requirements of the Project. The Contractor shall maximize the use and take advantage of BIM for the purpose of the Project to enhance team collaboration and coordination.
- 1.3.2 The BIM Execution Plan shall be regarded as a live document and developed, updated, and implemented in accordance with BS EN ISO 19650, BS 1192, and PAS 1192 Standards. Reference may be made to the BIM Project Execution Plan templates in the BS EN ISO 19650, BS 1192, and PAS 1192 Standards. After award of the Contract, the BIM Execution Plan shall be submitted to the Employer / Engineer for review and acceptance.

1.4. BIM Objectives, Responsibilities and Deliverables

Table 1 BIM Goals and Objectives

S. No.	Goal Description
1	Provision of standardized 3D digital construction document models which facilitate audit, analysis, construction and renovation.
2	Improved visualization and presentation of virtual designs to validate design goals such as aesthetics, layout, sightlines, safety, passenger flow, security, etc.
3	Reduce and eliminate building system construction errors by digital modelling of building system geometries to detect conflicts or clashes.
4	Provide evidence of a proper interface management extracting shop drawings from the model, CSD (Combined Service Drawings), SEM (Structural, Electrical, Mechanical) drawings, CCSM (Coordinated Combined Service Model) and providing evidence of Maintenance and Equipment Routing accessibility
5	Precise quantity take-off and estimate of asset costs and alternative schemes during the project life cycle.
6	Accurate documentation of building / asset systems geometry and data to facilitate and automate O&M operations.
7	Automated access to building asset information by linking the record information model (AIM/ABAM). This would include linked access to building system operation routines, maintenance manuals, equipment specifications and fabrication documents.

- 1.4.1 In general, overall BIM deliverables shall include a set of digital representations of the Project in the form of BIM Models, reports, CAD Drawings, and other non-geometrical data that describe the physical, functional and performance characteristics of the Project for the purpose of visualisation, simulation, analysis, collaboration, planning, and documentation throughout the project lifecycle.
- 1.4.2 BIM models, BIM services and all other BIM related deliverables provided throughout the contract phases shall at minimum meet the BIM objectives and requirements set out in this document.
- 1.4.3 The Contractor shall produce Project Information Model (PIM) for extracting Shop drawings, CSD, SEM and various drawings for construction purposes and upgrade it to Asset Information Model / As-Built Asset Model, (AIM/ABAM) fit for the purpose of asset management, with as-built details embedded (in 2D and 3D where applicable) for archival.
- 1.4.4 The Contractor shall Coordinate, update, share and submit BIM deliverables in accordance with the requirements, times and receiving parties as documented in the BIM Execution Plan to the Employer/Engineer for review.
- 1.4.5 Contractor shall provide with complete breakup of BIM level activities/ BIM submission programs / BIM deliverables in accordance with project milestones/ key dates that shall be jointly reviewed and agreed by the Employer/Engineer.
- 1.4.6 The Coordinated Combined Service Model (CCSM) shall refer to the model comprising of all disciplines involved throughout the stages of the project that is

- coordinated for purpose of construction by The Contractor and interfacing parties.
- 1.4.7 All necessary BIM models and other BIM deliverables developed by Contractor shall be provided to the System Wide Contractors (SWCs) as part of the information exchange, as required. All such information shall be provided at no cost to the System Wide Contractors (SWCs) in a timely fashion as specified in the BIM Execution Plan.
 - 1.4.8 The Contractor shall interface with the SWCs, and any other subcontractors, to obtain all necessary BIM services, BIM Models and other BIM related deliverables/information.
 - 1.4.9 The Contractor shall ensure that the ABAM/AIM tallies with the Actual Construction. This includes (1) geometries of BIM elements tally, and (2) any other common information requirements between these models (ABAM/AIM).
 - 1.4.10 Cut-off dates for exchange of Models by Model Authors to Model Users shall be the same as the cut-off date for exchange of information (Common Data Environment – Cloud) - (PMIS) and drawings as indicated in the Terms of Reference, unless otherwise agreed. Agreed cut-off dates for exchange of Models or other deliverables shall be documented in the BIM Execution Plan (BEP).
 - 1.4.11 Upon award of the Contract, all Detailed Design Models – Good For Construction / Issued For Construction / Construction Reference Design (GFC / IFC / CRD) shall be issued by the DDCs to the successful / appointed Contractor. The Lead Contractor will issue the Final Design Models, combined coordinated BIM models or the latest coordinated Construction models to the System Wide Contractors (SWCs) upon award of System Wide Contractor (SWCs) contract.
 - 1.4.12 During Construction stage, the Contractor is (are) to ensure that the latest issued updated Detailed Design Model (GFC / IFC / CRD) is incorporated into the ABAM / AIM at agreed /accepted intervals for the purpose of supporting construction coordination and design interfacing.
 - 1.4.13 Data sharing and coordination amongst various parties shall be carried out interactively, leveraging software technology. The process of coordination, collaboration and data sharing shall be led by the Lead Contractor and agreed among all parties involved in BIM Modelling and clearly documented in the BIM Execution Plan.
 - 1.4.14 The Contractor shall coordinate with interface contractors and engage them in regular 3D review process throughout the duration of the Project. Process may include regular meetings where both the coordinators, relevant design decision making Engineer/Employer are expected to attend
 - 1.4.15 AIM/ABAM Asset Information Model models of the respective Services shall be developed and verified by The Contractor and approved by the Engineer. SWC models shall be developed and finalised by the SWC. Lead Contractor shall coordinate with the SWCs and submit the coordinated model to the Employer / Engineer.

1.4.16 Timeline Simulation of the models - The Contractor shall prepare the PIM Model in the view of running timeline simulation. The elements available in the model should have the parameters related to timeline simulation of the model. The various phases during the project lifecycle to be adopted during constructing the BIM Model.

1.5. Interfacing Provisions

1.5.1 The lead Contractor shall progressively provide the individual model to the interfacing parties where applicable i.e., System Wide Contractors (SWCs) for them to continuously develop their BIM models (including the 2D drawings / hand sketches provided by various sub-contractors) for verification purpose and for developing the CCSM throughout the project. The level of details, development & information of the elements to be modelled shall be subjected to the Employer / Engineer acceptance and shall be sufficient for the purpose of clash detection and installation. The Lead Contractor, where applicable shall progressively provide the individual model to the above-mentioned interfacing parties for verification / Validation.

1.5.2 Contractor shall generate Project Information Model in compliance with Project's Information, Standards and in accordance with BEP. Contractor shall not generate information which is more than required and duplicate information generated by other contractors.

1.5.3 The Contractor shall coordinate with interfacing parties to verify and update the correctness of the models. In an event where there are disputes between The Contractor and interfacing parties, the decision of the Employer/Engineer shall be final. The Contractor shall submit these models and its associated files by the cut-off date for exchange of information indicated in Schedule of Key dates.

1.6. Coordinated combined service model (CCSM) submission

1.7.1 The Contractor shall coordinate and agree with the interfacing parties on any proposed changes to the models for purpose of coordination and development of the CCSM. The Contractor shall ensure all the changes are developed and agreed by the interfacing parties during the coordination process and shall be properly documented and submitted to the Employer/ Engineer in a timely and progressive manner.

1.7.2 The Contractor shall coordinate with Civil contractor to model all structural openings / penetrations and embedment for E&M and SWC Works. The CCSM shall also capture and coordinate services that are of diameter 25mm or more through the use of BIM. CCSM colour coding for E&M and SWC Works shall be submitted upon award of the Contract for Employer/ Engineer approval.

1.7.3 The Contractor shall coordinate with adjacent System Wide Contractors (SWC's) to ensure that their interfaces are spatially modelled.

1.7.4 A use of different BIM authoring tools for the station, viaduct, depot, and substation is envisaged, the Contractor shall be responsible to ensure full integration of their models on the different platforms used. All limitations to this integration must be

identified in the BIM Execution Plan and demonstrated to be unfeasible for implementation.

1.7.5 The Contractor shall lead and conduct Virtual design reviews (VDRs) / workshops after information exchange cut-off date and prior to the Coordinated Combined Services Drawing (CCSM) / Structural Electrical Mechanical (SEM) submission. The Contractor shall invite all interfacing parties including DDCs and Employer / Engineer to attend the workshop and shall demonstrate that clashes identified during the coordination meetings were resolved.

1.7.6 The Contractor shall ensure that a zero clash CCSM is used for extracting the shop drawings. The clash detection management strategy shall be elaborated in BEP and to be submitted for Employer / Engineer's approval. The Contractor shall attach a clash analysis report if there are clashes in the CCSM submission. The clash analysis report shall detail the BIM coordination and clash detection activities and submitted together with the CSD/SEM submission.

The report shall include but not limited to:

- i) Indication of clash detection / omission settings used in all clash detection.
- ii) Clash detection matrix indicating the numbers of clash between various disciplines.
- iii) Coordination and clash detection between interfacing parties' models.
- iv) Identification of all clashes with differentiation of Hard, Soft and Acceptable clashes.
- v) Classification of coordination issues and clashes with the three (3) different levels of priorities:
 1. Clashes that involved only two (2) interfacing parties shall be referred to as Code 1.
 2. Clashes that involved more than two (2) interfacing parties shall be grouped together as a clash group and be referred to as Code 2.
 3. Clashes that can only be resolved through design changes shall be referred to Code 3 and be brought to attention of the Engineer.

1.7.7 The Contractor shall provide viewpoints in the CCSM capturing areas with Code 3 clashes and non-compliance that requires the Employer/ Engineer attention. The annotations to these viewpoints shall be in sync with the clash analysis report for ease of identification.

1.7.8 For standardisation and to avoid missing data during the conversion from one software format to another, The Contractor shall submit the Coordinated Combined Services model in accordance with the software format adopted by the Employer's Consultant during the design stage upon Employer / Engineer's approval.

1.7.9 The Contractor shall submit the CCSM, the clash analysis report together with CSD / SEM drawings according to Schedule of Key dates.

1.7. Timeline Simulation of BIM Models

- a) The Contractor shall prepare the PIM Model in the view of running timeline simulation.
- b) The elements available in the model should have the parameters related to timeline simulation of the model.
The various phases during the project lifecycle to be adopted during constructing the BIM Model.

1.8. As-Built Asset Model (ABAM)/ Asset Information Model (AIM)

The elements shall correspond with the final implementation (ABAM) based on contractor's completed works. Model(s) shall include the following:

1. As-built conditions relative to design intent and construction means and methods
2. Native file formats and all associated and linked files for all:
 - Authoring models generated by The Contractor
 - Fabrication models by Contractor or his Sub contractors/ fabricators
3. Fully assembled and coordinated master model
Full description of how to reassemble the model and how to extract 2D documentation, software, and version number.

1.9.2 Contractor will prepare the ABAM / AIM models to reflect the fit for space management, building maintenance and modifications made during occupancy by the Operation & Maintenance team.

1.9.3 ABAM / AIM shall include data for installed equipment necessary for Operation and Maintenance, including by not limited to:

- Equipment Tag (name and number) per Design Documents
- Model Number
- Item Tracking Number
- Location code
- Cost Information
- Assembly drawings
- Manufacturer and manufacturing information
- Serial Number
- Installation Date
- System Information
- Performance Characteristics and Attributes
- Defect liability period
- References to O&M Manuals, Warranty Data, Training, and safety manuals
- Spare parts/materials, consumables
- Recommended operating procedures
- Recommended preventive maintenance procedures

2. Model Delivery

2.1. General

- 2.1.1 Upon completion of each stage and / or phase of the Contract, the BIM Manager or BIM Coordinator shall facilitate the transfer of model produced by The Contractor to the Employer/Engineer. The Contractor shall submit BIM models developed and relevant documents and drawings in Common Data Environment (CDE) online available to all project stakeholders as specified by Employer / Engineer. It is the Contractor's responsibility to ensure the delivery of the CCSM / PIM, ABAM / AIM in the aspects of building elements and components, system equipment and devices, object attributes and classification, submittals, or similar and model formats, etc.
- 2.1.2 The Contractor shall submit the CCSM / PIM and As-Built Asset Model (ABAM / AIM) in four major stages:
1. Stage 1 Deliverables: Before proceeding to extract the first revision of shop drawings from the model The model should be submitted along with other interfacing models for Engineer's review and approval.
 2. Stage 2 Deliverables: At each submission of Shop drawings submittal, the model should be submitted along with other interfacing models for Engineer's review and approval.
 3. Stage 3 Deliverables: After Substantial completion (Phases of ABAM / AIM submission to be elaborated in BEP for Employer / Engineer's Approval), the Contractor shall submit the completed ABAM / AIM to the DDC for final review and validation within 45 days.
 4. Stage 4 Deliverables: The Contractor shall submit the ABAM / AIM to the Employer / Engineer inclusive of all key building services equipment, for final review and acceptance of Engineer / Employer.
- 2.1.3 The following models of various project stages and other outputs in the deliverables:
1. Model-based schedule and phasing program
 2. Construction models (CCSM / PIM)
 3. Fabrication models (optional and if applicable)
 4. Model generated shop drawings
 5. As-built models (in both native proprietary and open BIM formats)
 6. ABAM / AIM and / or relevant testing and commissioning information for project commissioning, operations, and maintenance in format to Employer / Engineer acceptance
 7. Other additional value-added BIM services like VR (Virtual Reality), AR (Augmented Reality), Visual BI, Timeline Simulation of BIM Models, etc.

3. Ownership and Rights to BIM Deliverables

3.1. General

The Employer shall have the ownership and exclusive rights to all BIM Deliverables of the Project. The Employer has the full rights to grant its appointed agents the rights to use the BIM Deliverables for the purpose of the Project and subsequent operation and maintenance of the works at his discretion.

4. BIM Specification and Level of Detail

4.1. BIM Specification

- 4.1.1 The boundaries of the ABAM / AIM shall correspond to that of the Actual Construction. Unless otherwise specified by the Employer / Engineer, this shall cover the extent of engineering and construction required of the Contractor's scope of work. At minimum, this shall encompass corridors of the railway and depot if any. BIM models shall include all Architectural, Civil, Structural, Building Services and any other specialist systems / railway systems required to produce a complete digital representation of all buildings and facilities required for the purposes.
- 4.1.2 Temporary Works will not be included in the ABAM / AIM, unless left in place by The Contractor. However, submission of temporary works drawings for approval by the Employer / Engineer will still be necessary.
- 4.1.3 Existing utilities, structures, and facilities that interface with the proposed contract shall be modelled unless agreed otherwise, if any. Such existing elements shall be clearly demarcated in the ABAM / AIM and specified in the BIM Execution Plan.
- 4.1.4 BIM elements or objects are required to meet the BIM objectives or to describe the construction work accurately shall be created with parametric BIM authoring software by The Contractor. The Contractor shall liaise with the Engineer/Employer on the required parameter variables.
- 4.1.5 To the greatest extent practicable, the Contractor shall model all items/ elements that will be constructed and installed. In the event if any of the items/ elements that cannot be practicably modelled due to software limitations, The Contractor shall identify and list out all such limitations in the BIM Execution Plan with justification and shall be subjected to the acceptance by the Employer / Engineer.
- 4.1.6 The list of BIM elements and systems and the corresponding level of details required for each BIM element including the unit of measurement, geometric and non-geometric properties at each project phase shall be established and documented in the BIM Execution Plan.
- 4.1.7 The Contractor shall ensure that the ABAM / AIM can be used by the Employer with an acceptable level of service: The model should not lag during routine operations using BIM Authoring tools.

4.2. LEVEL OF DEVELOPMENT (LOD)

- 4.2.1 The level of development (LOD) for each model element is based on the model content criteria. These principles are based on 2019 Version BIM Forum Specification or Employer / Engineer's requirement.

4.3. Data Management: File Naming and Folder Naming Convention

- 4.3.1 A common naming convention for model file names, model views, legends, schedules, sheets, and links for the whole contract should be used to provide a common reference.
- 4.3.2 A standard folder structure convention will be provided after contract award. Both file naming and folder naming convention shall be followed and if any additional layers required by the project is to be developed by the Contractor's BIM Manager and proposed in the BIM Execution Plan, in consultation with the Employer/Engineer BIM Manager.

4.4. Drawing and Document Standards.

Links shall be maintained within the ABAM / AIM to enable automatic generation of drawings. As-built drawings shall be fully derived and extracted from ABAM / AIM. Drawings shall include, but not limited to plans, sections, elevations, quantities, and schedules, and shall be delivered as representations of, or extraction from BIM models. All 2D CAD data and deliverables shall follow Terms of Reference and Draughting and CAD standards in Appendix- Design Submission of Reports and Drawings.

4.5. Limitation and constraints on Data Entries in Model

To facilitate the limitation and constraints on codes in Data Registration Tools for MMS, a guide on coding will be provided upon award of Contract.

5. BIM Software and Formats for Exchange and Submittal

BIM exchange formats and protocols shall be developed and agreed by all parties involved in collaborating and contributing to the Model content. Agreed BIM exchange formats and protocols shall be documented in the BIM Execution Plan. The BIM Execution Plan must list the BIM software with Version and computer operating system used by The Contractor for this project. The software and operating systems shall be identified by vendor, product name, version identifier, patch number and data architecture (32bit/64bit). Listed software and listed operating systems shall not be changed or upgraded without the Engineer's acceptance.

5.1. BIM Format for submission

- 5.1.1 BIM Models submitted at various stages of project development or as and when requested by the Employer / Engineer shall be available in the format suitable for its purpose. In general, the following formats are required and shall be provided:

- DWF or 3D PDF for general viewing and archiving.
- Native format of BIM authoring or BIM related software applications for design reviews.
- Industry Foundation Classes (IFC), if requested.
- Construction-Operations Building Information Exchange (COBIE) for asset data, and
- Any other open standard format, as requested by the Employer / Engineer.

5.1.2 Software file formats and version to be used for the Project and for submission to the Employer / Engineer shall be agreed among the parties contributing to the Models before the start of the project. A list of the BIM deliverables shall be submitted for acceptance of the Engineer and the corresponding submission file formats shall be proposed in the BIM Execution Plan for the Employer / Engineer's acceptance.

5.2. Software Applications

All BIM authoring and detailing software applications proposed and used shall satisfy all the following:

- Be IFC certified by building SMART
- In compliance to BIM e-submission guidelines / CDE guidelines and requirements and possesses track record of having successfully completed the whole cycle of BIM e-submission / CDE guidelines for a new construction project, and seamlessly interoperable with commercially available coordination software applications.

5.2.1 BIM coordination applications shall be compliant to and support the prevailing version of Industry Foundation Class (IFC) file format

5.2.2 All BIM software and the versions to be used for the project shall be proposed in the BIM Execution Plan for the Employer / Engineer's approval before the start of the Project.

5.3. Asset Information Requirements (AIR)

5.3.1 At handover, Employer / Engineer requires asset information to be delivered as part of the information model. As per BS EN ISO 19650, BS 1192, and PAS 1192, Fulfilling employer's information exchange requirements using COBie - Code of Practice, the integrity of data included within the COBie schema, should be ensured as follows-

- Every hosted component should be assigned to at-least one Space, one Type, at least one System, at least one Zone.
- Every reference to other sheet should be valid.
- Every reference to Pick List enumerations and classifications should be valid.
- Enumerations specified in the Attributes and Pick Lists should be adhered to.

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

5.3.3 All required equipment shall include the following attributes-

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

5.3.4 Currently the Employer is in process of identifying and listing down the assets which will be important from operations and maintenance perspective, plus, the information parameters (object property sets) which needs to be attached with respective model elements to populate them with facility and asset management related information as and when it is available in project life cycle. Once this information is prepared by EMPLOYER, the same shall be shared with the DDCs and the Contractors. Detailed Design Consultant (DDC) and Contractors are required to attach the information parameters (object property sets) to respective BIM elements. This is to be undertaken irrespective of the data for that parameter field is required / available at that stage or not. This is to enable data to be included at stages later in the project life cycle.

5.4. System Performance

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

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

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

5.5. Coordinates

5.5.1 All the individual model files shall be geo-referenced to enable integration with GIS based applications and when a federated BIM model of any section of CMRL Phase II is prepared it should get properly aligned. All the components shall be geo-referenced to main control point, the co-ordinates for which shall be got validated / approved by Employer / Engineer. Following other points needs to be noted-

1. The BIM models shall be set at the correct latitude and longitude or defined survey point.
2. Real-world coordinate systems to be used and models to be produced to true

- height above project datum
3. Orientation of the project shall be based on true / actual north
 4. Sub-models of a single stretch or a building shall share the same survey point and coordinates.
 5. All the models produced in Revit / civil 3D, or any other equivalent software shall use the 'shared coordinates' system.
 6. Since the consultant also needs to share all information in IFC format, the consultants should ensure that the geo-referenced coordinates should also get successfully transferred into IFC format.

5.6. Model Production and Delivery Table (MPDT)

5.6.1 MPDT to meet following requirements:

- The Employer's BIM objectives
- The Employer's BIM Uses
- The Supplier's required stage-wise scope of work
- Generic Principles of Levels of Model Definition for building and infrastructure projects
- Exclusions in the model

6. Integration with Operation and Maintenance

6.1. General

- 6.1.1 As part of the requirements for Asset Management, the ABAM / AIM will serve as the interface between the O&M and other digital systems.
- 6.1.2 The principle behind the integration is the unique identification of all modelled elements (called asset tags), so that there is no ambiguity in different digital systems.
- 6.1.3 The Model Author is to tag each asset in the BIM Model as a property of the modelled element within the BIM software. For example, the "Mark" property may be used to hold this asset tag information.
- 6.1.4 Contractor shall reference the asset tags from ABAM / AIM and its associated drawings where given. The Contractor may propose his own tags, subject to approval of the Engineer / Employer. A coding guide for the asset tags will be provided upon award of Contract.

7. BIM Roles and Responsibilities

7.1. General

- 7.1.1 A BIM Manager shall be appointed for the Contract as the main point of contact for BIM to overall manage and coordinate the use and delivery of BIM for the Contract.
- 7.1.2 The BIM Manager shall ensure the appropriate implementation of the BIM Execution Plan and deliverables as well as the effective and efficient collaboration

and coordination of design. The roles and responsibilities of the BIM Manager shall encompass those indicated in BS EN ISO 19650, BS 1192, and PAS 1192 Standards, Project BIM Objective and Deliverables of this document. The roles and responsibilities of the BIM Manager and BIM Coordinators shall be agreed and documented in the BIM Execution Plan.

- 7.1.3 The appointed BIM Manager and BIM Coordinators shall have experience and qualification subject to the Employer / Engineer's acceptance.

8. Hardware

8.1. General

- 8.1.1 The Contractor shall provide one (1) set of hardware and software license to the Employer to carry review and clash detection analysis of the Coordinated Combined Services model till Completion of Whole Works. The software shall be in accordance with the software format adopted by the DDC's during the design stage. The specifications of the hardware and software shall be submitted to the Employer for acceptance.



CHENNAI METRO RAIL LIMITED
CHENNAI METRO RAIL PROJECT PHASE 2, CORRIDOR 4
TENDER No. C4-E&M-05

Supply, installation, testing, commissioning and training of Electrical, Fire protection and VAC works for 18 Elevated stations from Power House Station to Poonamallee Bypass station including Viaduct between the stations (Ch 10027.102 to Ch 25928.186), approach ramp, including Poonamallee Depot for Corridor 4 of Chennai Metro Rail Project Phase-II

PART – 2

EMPLOYER'S REQUIREMENTS

SECTION VIA

APPENDICES

MARCH 2022

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ANNEXURE -D Preliminary Interface sheets

	Interface Lead	Obligation of Interface Lead	Interface Follower	Obligation of Interface Follower
E&M vs Civil Contractor ECV 01, ECV 02 and DPT 01(Elevated Stations, Viaduct and Depot)				
1.	Civil Contractor	<p>Complete the construction of pump rooms with tanks / sumps, ASS rooms etc and shaft and share progress status on mutually agreed intervals.</p> <p>Shall issue the access permit to MEP contractor for E&M installation.</p>	E&M Contractor	<p>Review the progress status inline with the E&M installation program and coordinate with the Civil contractor.</p> <p>Share the E&M installation program to the Civil Contractor. Request access for E&M installation</p>
2.	Civil Contractor	<p>Complete the E&M Installation such as PDS pipe, pumps, treatment plants & associated structures, as per the civil contract scope and share the as built information to E&M contractor.</p> <p>Carryout necessary modifications for the Civil contractor's E&M installation as per the request of E&M contractor.</p>	E&M Contractor	<p>Review the as built information shared by the Civil contractor in line with the E&M contractor requirements.</p> <p>In case of deviations, the same shall be brought to the notice of the Engineer and request for modification as necessary to the Civil Contractor.</p>
3.	Civil Contractor	<p>Make the opening in wall, Floor and Roof as per the Structure Electrical and Mechanical (SEM) Drawing and share the as built information of the wall openings.</p> <p>Review the modification requirement shared by the E&M contractor and make necessary modifications for the MEP openings in wall, floor and roof.</p>	E&M Contractor	<p>Review the as built information shared by the Civil contractor and with the MEP Penetrations as per E&M contract requirements.</p> <p>In case of any deviations of size and location of the openings with respect to E&M contract requirement, the same shall be marked and shared with the Civil contractor for modification in the opening.</p>

	Interface Lead	Obligation of Interface Lead	Interface Follower	Obligation of Interface Follower
4.	Civil Contractor	Review the E&M equipment lifting hooks, plinths size and location for pumps shared by E&M contractor. Construct and provide information to the E&M contractor.	E&M Contractor	Share the E&M equipment lifting hooks, pumps plinth size and location to the Civil contractor.
5.	Civil Contractor	Technical rooms shall be ready as per the requirements of the E&M Contractor and shall co-operate for joint check.	E&M Contractor	Shall jointly check the technical rooms made ready by 'Civil contractor ' and to be confirmed
6.	Civil Contractor	Shall provide necessary arrangements like plinths/pedestal/ inserts to install E&M equipment in various locations at stations and Depot.	E&M Contractor	Shall request necessary arrangements like plinths/pedestal/inserts to install E&M equipment in various locations at stations and Depot.
7.	Civil Contractor	Shall provide necessary openings, sleeves, cut-outs, and shafts as per CSD/SEM/ builder's works drawings and requested by E&M contractor	E&M Contractor	Shall request necessary openings, sleeves, cut-outs, and shafts as per CSD/SEM/Builders Works drawings for E&M services to Civil contractor as required.
8.	Civil Contractor	Shall request the micro construction programme schedule of erection before erection starts.	E&M Contractor	Shall provide the micro construction programme schedule of erection.
9.	Civil Contractor	Shall install all the illuminated signs and share the Electrical load, locations and Electrical provisions to E & M contractor	E&M Contractor	Shall verify the requirements of illuminated signs and provide accordingly.
10.	Civil Contractor	Shall provide fire sealant material as per fire rating required wherever the openings to be closed after laying of cables.	E&M Contractor	Shall request fire sealant material wherever the openings to be closed after laying of cables.

	Interface Lead	Obligation of Interface Lead	Interface Follower	Obligation of Interface Follower
11.	Civil Contractor	Shall provide easiest/shortest access for lifting facilities and easy maintenance of E&M equipment	E&M Contractor	Shall jointly check the access for lifting facilities for E&M equipment for installation and easy maintenance and agree.
12.	Civil Contractor	Shall share the architectural finishes and other details of respective Room and layout as required for the E&M Contractor.	E&M Contractor	Shall request the architectural finishes from 'Civil Contractor' to finalise the E&M equipment finishes for aesthetical look.
13.	Civil Contractor	Shall provide the safety working atmosphere at work site.	E&M Contractor	Shall request the safety working atmosphere at work site.
14.	Civil Contractor	Shall request necessary installation of embedded & concealed materials like pipes, conduits, boxes etc. from E&M Contractor in advance before civil works starts.	E&M Contractor	Shall provide & install necessary embedded & concealed materials like pipes, conduits, boxes etc. to 'Civil Contractor' in the appropriate/ requested time.
15.	Civil Contractor	Civil Contractor shall Exchange his Program for each respective Rooms.	E&M Contractor	Contractor shall Exchange his Program with Civil Contractor.
Testing and commissioning				
1.	Civil Contractor	Shall attend the joint testing and do necessary correction as required.	E&M Contractor	Shall conduct joint test with suitable loads for temporary power supply.
2.	Civil Contractor	Shall keep the site free from obstacles and handover to E&M contractor for cable laying work	E&M Contractor	Shall request Space to be free of obstacles at the time of cable laying.
3.	Civil Contractor	Shall plan accordingly to meet the E&M contractors' requirement in compliances with the E&M works program.	E&M Contractor	In compliance with E&M works as per the program as required in the stages of works. E.g

	Interface Lead	Obligation of Interface Lead	Interface Follower	Obligation of Interface Follower
				1 st Fix, 2 nd Fix etc., and testing and commissioning.
4.	Civil Contractor	Provide temporary storage space for the cable trays at stations	E&M Contractor	Shall check the adequacy of the temporary storage space for cable trays at the stations and avail.
5.	Civil Contractor	Shall provide relevant opening in viaduct wherever required	E&M Contractor	Shall check and cooperate.
6.	Civil Contractor	Roof structure support for E&M services as required to be provided	E&M Contractor	E&M contractor to share services layout and support requirements shall be shared to the civil contractor, as required.
E&M Contractor vs OHE & Power Supply				
1.	E&M Contractor	Shall provide arrangements for Power and control cable tray with vertical raiser support inside ASS room and switchgear panel.	OHE & Power Supply Contractor	Shall jointly check the cable tray arrangements for cable routing/laying in ASS room and equipment etc.
2.	E&M Contractor	Shall provide MET provision at station on both ends	OHE & Power Supply Contractor	Shall jointly check MET provision at station on both ends. Connection from BEC to MET is in PS & OHE Scope.
3.	E&M Contractor	Shall provide fire alarm detection and controlling system at ASS and Traction room	OHE & Power Supply Contractor	Shall jointly check the arrangements fire alarm detection and controlling system at ASS and Traction room
4.	E&M Contractor	Shall provide Fire fighting arrangement like Fire extinguisher and fire suppression system and Panel flooding system only for the	OHE & Power Supply Contractor	Shall jointly check the provision of Fire fighting arrangement like Fire extinguisher and fire suppression system and Gas flooding system in ASS and Traction Rooms.

	Interface Lead	Obligation of Interface Lead	Interface Follower	Obligation of Interface Follower
		Transformer & GIS Panels in ASS and Traction Rooms.		
5.	E&M Contractor	Shall provide the earth pits for Transformer Neutral and MET provision for Body Earthing in ASS and Traction rooms.	OHE & Power Supply Contractor	Shall jointly check the provision of Earth pits, MET provisions for Transformer neutral and Body Earthing respectively. MET connection to Body earthing for PS equipment's in PS & OHE Contractor scope.
6.	E&M Contractor	Shall provide HT power and Control cable tray along with earthing and bonding at stations in ASS and Traction rooms.	OHE & Power Supply Contractor	Shall co-ordinate with E&M contractor for HT cable tray along with earthing and bonding at stations
7.	E&M Contractor	Shall obtain details of REF Phase CT and provide REF Phase CT at LT panels.	OHE & Power Supply Contractor	Shall provide neutral CT's and REF relay and share the details to E&M Contractor
8.	E&M Contractor	Shall provide relay protection details to PS & OHE Contractor.	OHE & Power Supply Contractor	Shall provide required details of protection setting and check protection Co-ordination with E&M contractor.
9.	E&M Contractor	Shall provide power supply feeder provision from LT Panel.	OHE & Power Supply Contractor	Shall Co-ordinate with E&M Contractor
10.	E&M Contractor	E&M Contractor shall Exchange his Program for each respective Rooms	OHE & Power Supply Contractor	OHE & Power Supply Contractor shall Exchange his Program with E&M Contractor.
Testing and Commissioning				
1.	E&M Contractor	Shall conduct Joint inspection of Earth MAT, earthing pits and take earth	OHE & Power Supply Contractor	Shall jointly check and co-ordinate with E&M contractor.

	Interface Lead	Obligation of Interface Lead	Interface Follower	Obligation of Interface Follower
		values and record.		
2.	E&M Contractor	Shall provide all the protection and tripping systems of all other SWC contractors in the stations to PS contractor.	OHE & Power Supply Contractor	All the tripping and protection systems shall be taken and shall be incorporated in the system in view of safety.
3.	E&M Contractor	Shall provide details required for CEIG inspection to PS & OHE Contractor.	OHE & Power Supply Contractor	Shall Co-ordinate with E&M Contractor
Maintenance				
1.	E&M Contractor	Shall Maintain and record the earth resistance values at pits.	OHE & Power Supply Contractor	Shall Verify and record the earth resistance values at pits.
E&M Contractor vs Escalators provider				
Construction/Installation Stage				
1.	E&M Contractor	Shall collect the details and provide the power supply till Isolator as per Escalator Contractor Requirements. Isolator shall be supplied by E&M Contractor.	Escalators Contractor	Shall provide the requirement of power supply to the Isolators and Co-ordinate with E&M Contractor.
2.	E&M Contractor	Dual earthing till Escalator isolator, Main Earth Terminal (MET) shall be provided by E&M Contractor.	Escalators Contractor	Shall provide the earthing requirement and Co-ordinate with E&M Contractor.
3.	E&M Contractor	Cable & cable Containment (Power) shall be provided up to isolator by E&M Contractor. Containment / Raceway / Conduit from isolator to escalator to be provided by E&M Contractor.	Escalators Contractor	Shall provide cable tray (Power and Control) requirement and Co-ordinate with E&M Contractor.

	Interface Lead	Obligation of Interface Lead	Interface Follower	Obligation of Interface Follower
4.	E&M Contractor	Shall provide Fire Alarm Control Module as per Escalator Contractor requirement. Shall provide conduits from Fire Alarm Control Module to Escalator control panel.	Escalators Contractor	Shall provide the details to E&M Contractor and provide the volt free terminal. Fire Alarm Cable from Fire Alarm Control Module to Escalator Control Panel shall be supplied by Escalator Contractor.
5.	E&M Contractor	Shall request for BMS interface details and necessary open communication protocol and termination details from Escalator contractor.	Escalators Contractor	Shall provide the BMS interface details and necessary open communication protocol and termination details to E&M Contractor.
6.	E&M Contractor	E&M Contractor shall Exchange his Program for each respective Rooms	Escalators Contractor	Escalator Contractor shall Exchange his Program with E&M Contractor.
Testing and Commissioning				
1.	E&M Contractor	Escalator Contractor shall conduct test run jointly with E&M Contractor (Earth Continuity Test, Fire Alarm Tests and BMS Interface)	Escalators Contractor	Shall Conduct test run jointly with E&M Contractor (Earth Continuity Test and Fire Alarm Tests)
2.	E&M Contractor	Cause and Effect Matrix to be develop the concept requirement and shall coordinated during the testing and commissioning, as required for statutory approval.	Escalators Contractor	Escalator Contractor to provide the inputs and coordinate for preparation of Cause and Effect Matrix, during the testing and commissioning, as required for statutory approval as required
3.	E&M Contractor	Shall collect and verify megger values before termination.	Escalators Contractor	Shall provide the megger test report before termination at E&M panel.
Maintenance				
1.	E&M Contractor	As per the operation & maintenance manual submitted by E&M Contractor agreed by both the sides (during DLP period).	Escalators Contractor	As per the operation & maintenance manual supplied agreed by both the sides.
E&M Contractor vs Lifts Contractor				
Construction and Installation stage				

	Interface Lead	Obligation of Interface Lead	Interface Follower	Obligation of Interface Follower
1.	E&M Contractor	Shall collect the details and provide the power supply till Isolator as per Lift Contractor Requirements. Isolator shall be supplied by E&M Contractor Shall collect the details and provide the power supply till MAP / Controller as per Lifts Contractor Requirements.	Lifts Contractor	Shall provide the requirement of power supply to the Isolators and Co-ordinate with E&M Contractor. Shall provide the requirement of power supply to the MAP / Controller and Co-ordinate with E&M Contractor.
2.	E&M Contractor	Dual earthing till Lifts Main Earth Terminal (MET) shall be provided by E&M Contractor.	Lifts Contractor	Shall provide the earthing requirement and Co-ordinate with E&M Contractor.
3.	E&M Contractor	Cable & cable Containment (Power) shall be provided till MAP / Controller by E&M Contractor.	Lifts Contractor	Shall provide cable & cable tray (Power and Control) requirement and Co-ordinate with E&M Contractor.
4.	E&M Contractor	Shall provide Fire Alarm Control Module as per Lifts Contractor requirement. Shall provide conduits from Fire Alarm Control Module to MAP/Controller.	Lifts Contractor	Shall provide the details to E&M Contractor and provide the volt free terminal. Fire Alarm Cable from Fire Alarm Control Module to MAP/Controller. Shall be supplied Lifts Contractor.
5.	E&M Contractor	Shall request for BMS interface details and necessary open communication protocol and termination details from Lift contractor.	Lifts Contractor	Shall provide BMS interface details and necessary open communication protocol and termination details to E&M contractor.
6.	E&M Contractor	E&M Contractor shall Exchange his Program for each respective Rooms	Lifts Contractor	LIFT Contractor shall Exchange his Program with E&M Contractor.
Testing and Commissioning				

	Interface Lead	Obligation of Interface Lead	Interface Follower	Obligation of Interface Follower
1.	E&M Contractor	Lifts Contractor shall conduct test run jointly with E&M Contractor (Earth Continuity Test, Fire Alarm Tests, BMS Interface)	Lifts Contractor	Shall Conduct test run jointly with E&M Contractor (Earth Continuity Test and Fire Alarm Tests)
2.	E&M Contractor	Shall collect and verify megger values before termination.	Lifts Contractor	Shall provide the megger test report before termination at E&M panel.
Maintenance (DLP Period)				
1.	E&M Contractor	As per the operation & maintenance manual submitted by E&M Contractor agreed by both the sides (during DLP period).	Lifts Contractor	As per the operation & maintenance manual supplied agreed by both the sides.
E&M Contractor vs Platform Screen Doors provider				
1.	E&M Contractor	Shall Supply and Install primary common cable containment for PSG contractor within Station area	Platform Screen Gates	Shall co-ordinate and Interface with E&M contractor for primary common cable containment in station area.
2.	E&M Contractor	Shall Provide earths and earth bars for Platform screen doors and its equipment's to be installed in Stations	Platform Screen Gates	Shall verify the requirements of earths and earth bars.
3.	E&M Contractor	Provide permanent power from UPS with suitable protection devices	Platform Screen Gates	Install/Lay the Power cable from UPS panel to PSG equipment.
4.	E&M Contractor	E&M Contractor shall share BIM individual services drawings to PSG Contractor for Combined Service coordination.	Platform Screen Gates	shall coordinate with E&M contractor and prepare BIM individual services for PSG Equipment and incorporate.
5.	E&M Contractor	E&M Contractor shall Exchange his Program for each respective Rooms	Platform Screen Gates	PSG Contractor shall Exchange his Program with E&M Contractor.
Testing and Commissioning				

	Interface Lead	Obligation of Interface Lead	Interface Follower	Obligation of Interface Follower
1.	E&M Contractor	Shall jointly check the resistance of all earthing works and UPS power related to PSG Equipment made at station.	Platform Screen Gates	Shall jointly check the resistance of all earthing works and UPS power related to PSG Equipment at station
2.	E&M Contractor	Shall collect and verify megger values before termination.	Platform Screen Gates	Shall provide the megger test report before termination at E&M panel.
E&M Contractor vs AFC Provider				
1.	E&M Contractor	Shall Provide earths and earth bars for AFC and its equipment's to be installed in Stations	AFC	Shall verify the requirements of earths and earth bars.
2.	E&M Contractor	Provide permanent power from UPS with suitable protection devices.	AFC	Install/Lay the Power cable from UPS panel to AFC room
3.	E&M Contractor	Shall Supply and Install primary common cable containment/Raceway for AFC contractor.	AFC	Shall co-ordinate and Interface with E&M contractor for primary common cable containment/Raceway.
4.	E&M Contractor	E&M contractor shall Supply & Install Control Module (Voltage Free Dry contact (VFC)Type: Normally Open (NO), 5 Amps) in SCR.	AFC	The AFC contractor to coordinate and use the VFC points in Control Module for wiring to AFC system for opening of AFC gates in case of Fire.
5.	E&M Contractor	E&M Contractor shall share BIM individual services drawings to AFC Contractor for Combined Service coordination.	AFC	shall coordinate with E&M contractor and prepare BIM individual services for AFC Equipment and incorporate.
6.	E&M Contractor	E&M Contractor shall Exchange his Program for each respective Rooms	AFC	AFC Contractor shall Exchange his Program with E&M Contractor.
Testing and Commissioning				

	Interface Lead	Obligation of Interface Lead	Interface Follower	Obligation of Interface Follower
1.	E&M Contractor	Shall jointly check the resistance of all earthing works and UPS power related to AFC.	AFC	Shall jointly check the resistance of all earthing works and UPS power related to AFC.
2.	E&M Contractor	shall attend to test the AFC gate opening in fire mode.	AFC	shall jointly test the AFC gate opening in fire mode
3.	E&M Contractor	Shall collect and verify megger values before termination.	AFC	Shall provide the megger test report before termination at E&M panel.
E& M Contractor vs Signaling Contractor				
4.	E&M Contractor	Shall Supply and Install primary cable containment for Signalling contractor within Station area and upto SER including vertical cable tray riser inside the room.	Signaling Contractor	Shall co-ordinate and Interface with E&M contractor for primary cable containment in station area.
5.	E&M Contractor	Shall install earth terminals for SER room, SCR, as per Earthing and bonding requirements.	Signaling Contractor	Shall verify that the requirements of earthing system are met as per Earthing and bonding requirements.
6.	E&M Contractor	Provide permanent power from UPS with suitable protection devices.	Signaling Contractor	Shall install the power cables from the distribution panel in UPS room to SER.
7.	E&M Contractor	Shall supply and install Clean Gas flooding system in SER.	Signaling Contractor	shall co-ordinate and Interface with E&M contractor for installation of Clean Gas Flooding system in SER.
8.	E&M Contractor	E&M Contractor shall share BIM individual services drawings to Signalling Contractor for Combined Service coordination.	Signaling Contractor	shall coordinate with E&M contractor and prepare BIM individual services for signalling Equipment and incorporate

	Interface Lead	Obligation of Interface Lead	Interface Follower	Obligation of Interface Follower
9.	E&M Contractor	E&M Contractor shall Exchange his Program for each respective Rooms	Signaling Contractor	Signaling Contractor shall Exchange his Program with E&M Contractor.
10.	E&M Contractor	E&M Contractor shall share VAC equipment layout and agree with Signalling contractor.	Signaling Contractor	Signaling Contractor shall share Signalling equipment layout and agree with E&M Contractor.
Testing and Commissioning				
1.	E&M Contractor	Shall conduct the joint testing of UPS power and earth impedance with Signaling Contractor contractor	Signaling Contractor	Shall attend joint test with E&M contractor for testing of UPS power and earth impedance of all earths provided for stations.
2.	E&M Contractor	Shall conduct the joint testing and validate the results	Signaling Contractor	Shall attend joint load test with suitable loads for UPS supply.
3.	E&M Contractor	Shall collect and verify megger values before termination.	Signaling Contractor	Shall provide the megger test report before termination at E&M panel.

E& M Contractor vs Telecom Contractor				
1.	E&M Contractor	Shall Supply and Install primary cable containment for Telecom contractor within Station area and upto CER and Telecom closet including vertical cable tray riser inside the room.	Telecom Contractor	Shall co-ordinate and Interface with E&M contractor for primary cable containment in station area.

2.	E&M Contractor	Shall install Main earth terminals (MET) for CER room, SCR and telecom closets as per Earthing and bonding requirements	Telecom Contractor	Shall verify that the requirements of earthing system are met as per Earthing and bonding requirements
3.	E&M Contractor	E&M contractor shall Supply & Install Control Module (Voltage Free Dry contact (VFC) Type: Normally Open (NO) for PAVA/CCTV and ACID in CER.	Telecom Contractor	The Telecom contractor to coordinate and use the VFC points in Control Module for wiring to Telecom system.
4.	E&M Contractor	Provide permanent power from UPS with suitable protection devices.	Telecom Contractor	Shall install the power cables from the distribution panel in UPS room to CER .
5.	E&M Contractor	Shall supply and install Clean Gas flooding system in CER.	Telecom Contractor	shall co-ordinate and Interface with E&M contractor for installation of Clean Gas Flooding system in CER.
6.	E&M Contractor	E&M Contractor shall share BIM individual services drawings to Telecom Contractor for Combined Service coordination.	Telecom Contractor	shall coordinate with E&M contractor and prepare BIM individual services for Telecom Equipment and incorporate
7.	E&M Contractor	E&M Contractor shall Exchange his Program for each respective Rooms	Telecom Contractor	Telecom Contractor shall Exchange his Program with E&M Contractor.
8.	E&M Contractor	E&M Contractor shall share VAC equipment layout and agree with Telecom contractor.	Telecom Contractor	Telecom Contractor shall share Telecom equipment layout and agree with E&M Contractor.
9.	E&M Contractor	E&M Contractor Shall provide the BMS interface details and necessary open communication protocol and termination details to Telecom Contractor.	Telecom Contractor	Telecom Contractor shall request for BMS interface details and necessary open communication protocol and termination details from Telecom contractor.
10.	E&M Contractor	E&M Contractor shall share LED Light, Power supply, Power Socket, Fire Detector inside Telecom room as per approved CRD/GFC drawings.	Telecom Contractor	Telecom Contractor shall request as per approved CRD/GFC drawings LED Light, Power supply, Power Socket, Fire Detector inside Telecom room.

Testing and Commissioning				
1.	E&M Contractor	Shall conduct the joint testing of UPS power and earth impedance with Telecom contractor	Telecom Contractor	Shall attend joint test with E&M contractor for testing of UPS power and earth impedance of all earths provided for stations.
2.	E&M Contractor	Shall conduct the joint testing and validate the results	Telecom Contractor	Shall attend joint load test with suitable loads for UPS supply.
3.	E&M Contractor	Shall collect and verify megger values before termination.	Telecom Contractor	Shall provide the megger test report before termination at E&M panel.

Annexure-E Master Interface Matrix

	C-4 E&M-05	Elevated Civil ECV 01	Elevated Civil ECV 02	Depot Civil DPT 01	Power Supply & Traction	Signaling	Telecom	AFC	PSD	LIFTS	ESCALATORS	Depot Special Machines	Track
C-4 E&M-05		X	X	X	X	X	X	X	X	X	X	X	X
Elevated Civil ECV 01	X		X		X	X	X	X	X	X	X		X
Elevated Civil ECV 02	X	X		X	X	X	X	X	X	X	X		X
Depot Civil DPT 01	X		X		X	X	X	X	X	X		X	X
Power Supply & Traction	X	X	X	X		X	X					X	X
Signaling	X	X	X	X	X		X		X			X	X
Telecom	X	X	X	X	X	X		X	X				
AFC	X	X	X	X			X						
PSD	X	X	X	X		X	X						
LIFTS	X	X	X	X									
ESCALATORS	X	X	X										
Depot Special Machines	X			X	X	X							X
Track	X	X	X	X	X	X						X	



CHENNAI METRO RAIL LIMITED

CHENNAI METRO RAIL PROJECT PHASE 2, CORRIDOR 4

TENDER No. C4-E&M-05

Supply, installation, testing, commissioning and training of Electrical, Fire protection and VAC works for 18 Elevated stations from Power House Station to Poonamallee Bypass station including Viaduct between the stations (Ch 10027.102 to Ch 25928.186), approach ramp, including Poonamallee Depot for Corridor 4 of Chennai Metro Rail Project Phase-II

PART 2

SECTION VI A

EMPLOYER'S REQUIREMENTS

APPENDIX-6

INDICATIVE MANUFACTURERS / SUPPLIERS

MARCH 2022

LIST OF INDICATIVE MAKES FOR E & M EQUIPMENT AND MATERIALS

- 1.0 Contractor shall seek prior material approval from the Employer/ Engineer for all materials/Vendors, regardless of meeting the technical specifications and other criteria stipulated in the Contract.

ELECTRICAL

SL.NO	ITEMS	INDICATIVE MAKES
1	LV PANELS	BLOKSET, ArTuk, SIVACON, Ti, RITTAL, EL STEEL
2	AIR CIRCUIT BREAKERS (ACB)	SCHNEIDER, ABB, SIEMENS, L&T
3	MCCB / MPCB	SCHNEIDER, ABB, SIEMENS, L&T
4	SFU / SDF	SCHNEIDER, ABB, SIEMENS, L&T
5	PROTECTIVE RELAYS	SCHNEIDER, ABB, SIEMENS, L&T, ALSTOM (AREVA)
6	SPD / SURGE ARRESTORS	OBO, HAGER, HAKEL, ABB, SIEMENS, CAPE, ZOTUP, PHOENIX, HAVELLS, MERSEN.
7	HPFC PANEL / AHF PANEL	SCHNEIDER, DELTA, ABB, P2 POWER,
8	ATS / ISOLATOR / CHANGEOVER SWITCH	SCHNEIDER, ABB, SOCOMEC, ASCO
9	CAST RESIN CURRENT TRANSFORMERS	AE, KAPPA, KALPA, RISHABH, L&T, G&M (GILBERT & MAXWELL), Newtek Electricals.
10	DIGITAL METERS	SCHNEIDER, ABB, SIEMENS, RISHABH, SECURE, L&T, ENERCON
11	SELECTOR SWITCHES	KAYCEE, L&T (SALZER), BCH, SCHNEIDER, ABB
12	INDICATING LAMPS AND PUSH BUTTONS	L&T, BCH, SIEMENS, SCHNEIDER, ABB
13	STARTERS / VFD / SOFT STARTERS	SCHNEIDER, ABB, SIEMENS, L&T, DANFOSS, FUJI
14	DISTRIBUTION BOARDS	SCHNEIDER, SIEMENS, ABB, HAGER, LEGRAND, INDO ASIAN
15	PLC	GE- FANUC, EMERSON, SCHNEIDER, ROCKWELL, SIEMENS, PHOENIX, HIMA, ABB, HONEYWELL
16	ETHERNET SWITCH	EMULEX, CISCO, ARUBA, HP, PHOENIX
17	SMPS	DELTA, ABB, SCHNEIDER, PHOENIX
18	MCB / RCCB	SIEMENS, SCHNEIDER, ABB, HAGER, LEGRAND, L&T, HAVELLS
19	POWER & AUXILIARY CONTACTORS	SIEMENS, SCHNEIDER, ABB, L&T

SL.NO	ITEMS	INDICATIVE MAKES
20	LT POWER CABLES FRLS/FRLSZH AL / CU XLPE FS/NON-FS	KEI, RR KABEL, POLYCAB, KEC, LAPP, THERMO CABLE, DUCAB, SPECIAL CABLES, APAR Industries
21	CONTROL CABLES	KEI, LAPP, RR KABEL, POLYCAB, KEC, THERMO CABLE, DUCAB, SPECIAL CABLES, APAR Industries
22	CABLE LUGS / THIMBLES CU /AL	DOWELLS, JAINSON, POLYCAB, RAYCHEM
23	SINGLE/DOUBLE COMPRESSION GLANDS	COMET, DOWELLS, BALIGA, COSMOS, RAYCHEM
24	CABLE JOINTING & TERMINATION KITS	RAYCHEM, 3M
25	TERMINAL BLOCKS & CAGE CLAMPS	ELMEXX, PHOENIX, WAGO, CONNECTWEL
26	GI CONDUIT PIPES & ACCESSORIES ISI MARKED	BEC, STEELKRAFT, AKG, SUPER SALES, JAVERI
27	CU CONDUCTOR FRLS PVC INSULATED WIRES / FS COPPER WIRES ISI MARKED	KEI, HAVELLS, RR KABEL, POLYCAB, THERMO CABLE, LAPP, DUCAB, APAR Industries
28	MODULAR SWITCHES, SOCKET OUTLETS & WIRING ACCESSORIES WITH MOULDED COVER PLATES	HAGER, LEGRAND, CRABTREE, MK ELECTRIC, SCHNEIDER, ABB, SIEMENS, CLIPSAL, WIPRO
29	INDUSTRIAL SOCKETS (INCLUDING WEATHER-PROOF TYPE)	HENSEL, HAGER, LEGRAND, MENNEKES, SCHNEIDER, ABB, L&T
30	LED LIGHT FITTINGS (PUBLIC AREA/FOH)	PHILIPS, LIGHTING TECHNOLOGIES, BANBURY LIGHTING, JAQUAR, REGENT, BAJAJ
31	LED LIGHT FITTINGS BACK OF ROOMS	PHILIPS, LIGHTING TECHNOLOGIES, BANBURY LIGHTING, CROMPTON, ZUMTOBEL, BAJAJ, EVEREADY, PANASONIC, HAVELLS
32	LIGHTING CONTROL SYSTEM	SCHNEIDER, LUTRON, LEGRAND, PHILIPS, ABB, HELVAR
33	WALL / CEILING FANS	BAJAJ, CROMPTON, HAVELLS, ORIENT
34	STREETLIGHTS / OUTDOOR LIGHTS	PHILIPS, LIGHTING TECHNOLOGIES, K LITE, BAJAJ, HAVELLS, CROMPTON
35	HIGH MAST LIGHT WITH POLES	BAJAJ, PHILIPS, HAVELLS, CROMPTON
36	STREET LIGHT POLES	BAJAJ, CROMPTON, K LITE
37	UPS SYSTEM	SCHNEIDER, DELTA, VERTIV, EATON, ABB, FUJI
38	UPS BATTERY (Li-B)	SAMSUNG, LG, DELTA
39	CABLE TRAYS AND ACCESSORIES	INDIANA, PROFAB, OBO, NIEDAX, RUKUMANI
40	RACEWAYS / CABLE MGMT SYSTEMS	PROFAB, OBO, NIEDAX, INDIANA, LEGRAND

SL.NO	ITEMS	INDICATIVE MAKES
41	BUSDUCT (SANDWICH TYPE)	C&S ELECTRIC, L&T, ANAND POWER, SCHNEIDER
42	LIGHTING BUS TRUNKING	C&S ELECTRIC, LEGRAND, SCHNEIDER, ABB, EATON
43	DIESEL ENGINE	CATERPILLAR, KIRLOSKAR, CUMMINS
44	ALTERNATOR	STAMFORD, LEROY SOMER, OR AS PER MANUFACTURER OF DG SET
45	DG CONTROLLER PLC	WOODWARD, SCHNEIDER, ROCKWELL, SIEMENS
46	SILENCERS	NEILSON OR ANY OTHER EQUIVALENT CONFORMING WITH CPCB NORMS
47	EARTHING AND LIGHTNING PROTECTION SYSTEM (GI/CU/SS)	DEHN, OBO, ERICO, JEF TECHNO, ABB, JMV, CAPE, AXIS, RAYCHEM
48	JUNCTION BOXES (INCLUDING WEATHER-PROOF TYPE)	HENSEL, RITTAL, LEGRAND, MENNEKES, HAGER, CAPE
49	ANCHOR FASTENERS	HILTI, FISHER, WUERTH (Please note that ETA Certification is mandatory for using/supplying fasteners for load bearing structural members)
50	SUPPORTING MATERIAL AND SYSTEM FOR CABLE TRAY	HI-TECH, MUPRO, HILTI, FISHER
51	FIRE SEALANT	HILTI, FISHER, 3M, STI, PROMASEAL, ROXTEC
52	EMERGENCY EXIT SIGNAGES	PROLITE AUTOGLO, BAJAJ
53	STRUCTURAL STEEL	TATA / SAIL / JINDAL STEEL AND POWER / JSW / ESSAR/ KL STEEL
54	MCC STARTER PANELS	HAROLD, FORMA PLASTIC, TESLA, OHM ENERGY

VAC

SL. NO	ITEMS	INDICATIVE MAKES
1	VRF UNITS (INDOOR, OUTDOOR AND CONTROLLER) AND ACCESSORIES	LG, DAIKIN, CARRIER, TOSHIBA, HITACHI, MITSUBISHI, MIDEA, SAMSUNG
2	FANS	KRUGER / GREENHECK / SYSTEM AIR/ZIEHL ABEGG/ EBM PAST / VTS / FLAKTWOOD
3	REFRIGERANT COPPER PIPES & FITTINGS	MEHTA / RAJCO / MANDEV/UNIFLOW
4	COPPER TUBE INSULATION	ARMACELL / K FLEX/LLOYD INSULATION / HIRA TECH
5	GALVANISED STEEL AND STAINLESS STEEL SHEET AND PIPES	TATA / JINDAL / ESSAR / SAIL

SL. NO	ITEMS	INDICATIVE MAKES
6	PRE-FABRICATED DUCTS	ROLASTAR / VENUS OR EQUIVALENT MANUFACTURER
7	FIRE RATED PAINT(GASKET / SEALANT)	FLAMEBAR / PROMAT/ MURUGAPPA MORGAN
8	FIBRE GLASS INSULATION	UP TWIGA / LLOYD/ MURUGAPPA MORGAN
9	ROCKWOOL INSULATION	ROCKWOOL / MURUGAPPA MORGAN / LLOYD
10	GRILLES/DIFFUSERS & LOUVERS	RUSKIN TITUS / SYSTEM AIR / AIR MASTER / CARYAIRE/ TROX
11	FIRE DAMPERS /MSD/MFSD & ACCESS DOORS	GREENHECK / TROX / RUSTIN TITUS / SYSTEM AIR/ AIR MASTER
12	MANUAL VCD	AIR MASTER / RUSKIN TITUS / SYSTEM AIR / GREENHECK / TROX
13	HIGH TEMPERATURE VCD	RUSKIN TITUS / GREENHECK / TROX / SYSTEM AIR/ AIR MASTER
14	NRD-(NON-RETURN DAMPER) AND PRD-PRESSURE RELIEF DAMPER	RUSKIN TITUS / GREENHECK / TROX / SYSTEM AIR/ AIR MASTER
15	SOUND ATTENUATOR	TROX / RUSKIN TITUS / GREENHECK / / KRUGER / SYSTEM AIR
16	FIRE STOPPING / FIRE SEALANT & MATERIALS	HILTI, FISHER, 3M, STI, PROMASEAL, ROXTEC
17	SUPPORT MATERIAL AND SYSTEM FOR DUCTWORK, PIPE WORKS AND REFRIGERANT PIPE TRAY WORK	HI TECH / MUPRO / HILTI /FISCHER
18	VIBRATION ISOLATORS	RESISTO FLEX / KANWAL INDUSTRIES
19	WELDING ELECTRODES	ESAB/ ADVANI-OERLIKON(ADOR WELDING)/HILTI
20	REFRIGERANT PIPE TRAY / COVERING SHEET	PROFAB / INDIANA / RUKUMANI/ OBO/ NIEDAX
21	VFD	DANFOSS/ABB/SIEMENS/ SCHINEDER / FUJI
22	AHU	VTS / SYSTEMAIR / FLAKTWOOD / EDGETECH / ZECO / CARRIER
23	SENSOR	HONEYWELL/SIMENS/OMICORN/ GREYSTONE
24	AIR FILTER	THRMADYNE/AAF/AEROSOL/CAMFILL / SPECTRUM
25	UVGI EMITTERS	AEROPURE/ RUKS/ SANUVOX/JOHNSON CONTROL

SL. NO	ITEMS	INDICATIVE MAKES
26	MOTORS	ABB/ SIEMENS/ MARATHON/ EBM PAPST/ ZIEHL-ABEGG
27	HVLS (HIGH VOLUME LOW SPEED)	GREENHECK/ KRUGER /KALE BRAYAN / HELIFANS / KELLYES / HUNTER INDUSTRIAL / VENCO / BIG ASS FANS
28	INVERTER AIR CONDITIONING UNIT	LG, DAIKIN, CARRIER, TOSHIBA, HITACHI, MITSUBISHI, MIDEA, SAMSUNG, VOLTAS, BLUE STAR, O-GENERAL
29	DIFFERENTIAL PRESSURE GAUGE	DWYER / WIKA / SIEMENS/HONEYWELL
30	PLC AND ACCESSORIES	GE-FANUC, EMERSON, SCHNEIDER, ROCKWELL, SIEMENS, PHOENIX, HIMA, ABB, HONEYWELL
31	PM 10/PM 2.5	HONEYWELL/GREYSTONE/OMICRON
32	AIR CURTAIN	VTS, EURONICS, RUSSEL, TRISTAR
33	ACTUATOR	HONEYWELL, BELIMO, SIEMENS

FIRE FIGHTING

SL.NO	ITEMS	INDICATIVE MAKES
1	ELECTRICAL FIRE PUMPS AND DIESEL ENGINE FIRE PUMP	KIRLOSKAR / MATHER & PLATT / GRUNDFOS / NAFFCO / ARMSTRONG / LUBI
2	MOTORS	KIRLOSKAR / ABB / SIEMENS / ALSTOM / CROMPTON GREAVES
3	STARTERS, SWITCHES / SWITCH FUSE UNITS	AS PER ELECTRICAL LIST
4	DIGITAL METERS	AS PER ELECTRICAL LIST
5	PRESSURE SWITCH	INDFOSS / SWITZER / MORLEY / SYSTEM SENSOR
6	PRESSURE GAUGE	FIEBIG / H. GURU / BAUMER / FORBES MARSHALL / WAAREE/ WIKA
7	PIPES (MS & GI)	TATA / JINDAL HISSAR/ APL APOLLO/SAIL / SURYA ROISHINI
8	DI PIPES- K7 & K9	LANCO (SRIKALAHASTHI PIPES LTD.), TATA METALIKS KUBOTA, CHANDRANCHAL INFRASTRUCTURE LTD. & JINDAL SAW.
9	FITTINGS:	

SL.NO	ITEMS	INDICATIVE MAKES
	A) DI / GALVANISED GROOVED FITTINGS	VICTUALIC/ JAINSONS/TYCO/NATIONAL/SMITH COOPER
	B) GI THREADED FITTINGS	DECCAN METAL / B&M EQUIVALENT
10	SLUICE VALVE / GATE VALVE OS&Y	KIRLOSKAR / LEADER/ SANT/ KARTAR/ADVANCE/ LEHRY/ ZOLOTO/ HD FIRE / NEWAGE / TYCO / VICTAULIC
11	GUNMETAL/STAINLESS STEEL VALVES (FULL WAY & CHECK VALVES)	
	A) CLASS I	LEADER / SANT / KARTAR/ADVANCE/LEHRY/ZOLOTO
	B) CLASS II	LEADER / SANT / KARTAR/ADVANCE/LEHRY/ZOLOTO
12	NON-RETURN VALVES	LEADER / SANT / KARTAR/ADVANCE/LEHRY/ZOLOTO/ AUDCO / HD FIRE / NEWAGE / TYCO / VICTAULIC
13	BUTTERFLY VALVE (NORMAL / SUPERVISORY)	LEADER / SANT / KARTAR/ADVANCE/LEHRY/ AUDCO / TYCO / VICTAULIC / NEWAGE/ HD FIRE
14	HYDRANT VALVE	NEWAGE / MINIMAX /TYCO
15	HOSE REEL TUBE (THERMOPLASTIC SYNTHETIC REINFORCED)	KESARA PLAST / MINIMAX /TYCO/NEWAGE
16	HOSE PIPE (RRL TYPE)	TYCO / NEWAGE / MINIMAX / SAFEX / ZENITH
17	BRANCHPIPE WITH NOZZLE	NEWAGE / SAFEGUARD / MINIMAX/TYCO
18	HOSE BOX	REPUTED MAKE AS PER IS SPECIFICATION SUBJECT TO CLIENT APPROVAL
19	PAINTS FOR EXPOSED PIPES	NIPPON PAINTS / ASIAN PAINTS / BERGER / SHALIMAR
20	ANCHOR FASTENERS	HILTI / FISHER / WUERTH (Please note that ETA Certification is mandatory for using/supplying fasteners for load bearing structural members)
21	WRAPING & COATING MATERIALS FOR UNDER GROUND PIPES	I W L (PYPKOTE) / EQUIVALENT
22	Y-TYPE / SUCTION STRAINER	ADVANCE/ SANT/ AUDCO/LEHRY / HD FIRE / TYCO / VICTAULIC
23	FOOT VALVE WITH STRAINER	SANT/ LEADER / ZOLOTO / ADVANCE/AUDCO
24	SPRINKLERS	TYCO / HDFIRE / GRINNEL / STAR / VICTAULIC / KARTAR

SL.NO	ITEMS	INDICATIVE MAKES
25	ALARM VALVE (INSTALLATION VALVE)	HDFIRE / SPRAYSAFE / VICTAULIC /TYCO
26	WATER MOTOR GONG & TRIMS	HDFIRE / VICTAULIC / TYCO
27	FLOW SWITCHES	SWITZER / FORBES MARSHALL / GEM / MACDONALD / GRINNEL / SYSTEM SENSOR / HD FIRE
28	AIR RELEASE VALVE	ADVANCE/ ZOLOTO / AUDCO/LEHRY
29	BALL VALVE	VICTAULIC / TYCO/ ADVANCE/ ZOLOTO / AUDCO / LEHRY
30	CAST IRON NON- RETURN VALVE DOUBLE FLANGED	ADVANCE/ ZOLOTO / AUDCO/LEHRY /KARTAR
31	RUBBER GASKET	REPUTED MAKE AS PER IS SPECIFICATION SUBJECT TO CLIENT APPROVAL
32	PORTABLE FIRE EXTINGUISHER	MINIMAX/KANEX/SAFEX/ZENITH/SAFEGUARD
33	TEST FLOW METER	GERAND/ VICTAULIC/TYCO
34	PRESSURE RELIEF VALVE	INDFOSS/ SYSTEM SENSOR / VICTAULIC / TYCO
35	EXPANSION BELLOW	EASYFLEX/ RESISTOFLEX/UNINAM / LEHRY
36	CLEAN AGENT NOVEC 1230	TYCO / 3M/ ANSUL / KIDDE/ SIEMENS / SEVO SYSTEM
37	AEROSOL	FIREPRO OR EQUIVALENT
38	PRESSURE VESSEL TANK	REPUTED MAKE AS PER SPECIFICATION SUBJECT TO CLIENT APPROVAL
39	FIRE SUITE AND PROTECTION DEVICES	PYROTEK / SAFTY WARE / BULLARD / LUXFER
40	DAY OIL TANK	REPUTED MAKE AS PER SPECIFICATION SUBJECT TO CLIENT APPROVAL

FIRE ALARM SYSTEM

SL.NO	ITEMS	INDICATIVE MAKES
1.	FIRE SENSORS & MODULE	NOTIFIER/ GE EDWARDS/ SIEMENS / SIMPLEX
2.	MAIN CONTROL PANEL / SUB ALARM CONTROL PANEL/ REPEATER PANEL/ GAS RELEASE PANEL	NOTIFIER/ GE EDWARDS/ SIEMENS / SIMPLEX
3.	MANUAL CALL STATIONS/ HOOTERS/IO MODULES/ STROBES / TELEPHONE JACK / SMPS	NOTIFIER/ GE EDWARDS/ SIEMENS / SIMPLEX
4.	COMMUNICATION CABLE -	KEI/ LAPP/ KEC/ RR KABEL/ FINOLEX/ POLYCAB/ THERMO CABLE
5	FIRE ALARM CABLE	KEI/ LAPP/ KEC/ RR KABEL/ FINOLEX/ POLYCAB / THERMO CABLE

6	CONDUITS AND ACCESSORIES	AS PER ELECTRICAL LIST
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SCADA / BMS

SL.NO	ITEMS	INDICATIVE MAKES
1	MASTER CONTROL EQUIPMENT'S(PLC)	GE-FANUC, ROCKWELL, HONEYWELL, EMERSON, HIMA, SCHNEIDER, SIEMENS, ALLEN BRADLEY, MITSUBISHI
2	SCADA CENTRAL PROCESSING EQUIPMENT (WORK STATION) (SERVER)	HP, DELL, FUJI, TOSHIBA, APPLE
3	SOFTWARE-HMI	GE-FANUC, ROCKWELL, HONEYWELL, EMERSON, HIMA, SCHNEIDER, SIEMENS, ALLEN BRADLEY, MITSUBISHI
4	PLC HOUSING CUBICLES/PANELS	RITTAL, HOFFAN. PENTAIR
5	REMOTE I/O , AND RELATED COMPONENTS AND MOUNTING PANEL - (AS PER IO SUMMARY)	GE-FANUC, ROCKWELL, HONEYWELL, EMERSON, HIMA, SCHNEIDER, SIEMENS, ALLEN BRADLEY, MITSUBISHI
6	AIR FLOW DIFFERENTIAL & PRESSURE SWITCHES	SIEMENS, GE, ROCKWELL OR EQUIVALENT
7	DUCT TEMPERATURE SENSOR	SIEMENS, GREYSTONE, ROCKWELL OR EQUIVALENT
8	TWO WAY AND THREE-WAY MOTORIZED VALVES WITH ACTUATORS	SIEMENS, HONEYWELL, GE , OR EQUIVALENT
9	AC CURRENT TRANSDUCER	AE, MECO, PHOENIX OR EQUIVALENT
10	AC VOLTAGE TRANSDUCER	AE, MECO, PHOENIX OR EQUIVALENT
11	MOTORIZED BUTTERFLY VALVE	HONEYWELL, SIEMENS, LEHRY
12	BATTERY VOLTAGE TRANSDUCER	AE, MECO, PHOENIX OR EQUIVALENT
13	FREQUENCY TRANSDUCER	AE, MECO, PHOENIX OR EQUIVALENT
14	DIFFERENTIAL TRANSDUCER	HONEYWELL OR EQUIVALENT
15	FLOW METER	JN MARSHALL, TYCO, VICTAULIC, VIKING, FEDERAL
16	SPACE SENSOR	SIEMENS, GERYSTONE OR EQUIVALENT
17	PRESSURE TRANSDUCER	GERYSTONE OR EQUIVALENT
18	SERVER PC	HP, DELL, FUJI, TOSHIBA, APPLE
19	MONITOR	HP, DELL, FUJI, TOSHIBA, APPLE
20	DOT MATRIX PRINTER	EPSON, HP, CANON, RICOH
21	SECOND PRINTER- LASERJET	EPSON, HP, CANON, RICOH

22	HUB FOR TCP AP, NETWORK SWITCH	EMULEX, CISCO, ARUBA, HP, PHOENIX, MOXA, ALCATEL-LUCENT, D-LINK
23	LIQUID LEVEL SWITCH	TECHTROL, LEVEL TECH OR EQUIVALENT
24	NOTEBOOK PC	HP, DELL, FUJI, TOSHIBA, APPLE
25	NETWORK CABLES (CAT 6, FIBER OPTIC & PATCH CORDS)	MOLEX/TYCO/LAPP/BIRLA ERICSON/ CISCO/ D-LINK / BELDEN/ UNIVERSAL/ AKSH
26	CONTROL CABLES	KEI/ LAPP/ KEC/ RR KABEL/ DUCAB/ POLYCAB/ THERMO CABLE/ BONTON/ CARDS CABLE
27	DDC CONTROLLER	HONEYWELL, SIEMENS, JOHNSON CONTROL, DISTECH CONTROLS
28	WIND VELOCITY SENSOR	HONEYWELL/ OMICRON / SIEMENS / DAVISON / VIRTUAL HYDROMET
29	ASPIRATION TYPE SMOKE DETECTION	SIEMENS / NOTIFIER / XTRALIS

COMPRESSED AIR APPARATUS

SL.NO	ITEMS	INDICATIVE MAKES
1.	COMPRESSOR & ACCESSORIES	ATLAS CAPCO/KESER/ CHICAGO/ ELGI/ INGERSOLL-RAND
2.	SS PIPE	PRAKASH SURYA/JINDAL HISSAR/TATA/SWASTIK/ LEGRIS/ LUTHRA
3.	SS PIPE FITTING	UNIQUE/ ZOLOTO/ KENT/ MUPRO
4.	BALL VALVE /BUTTERFLY VALVE	ZOLOTO/LEADER/SANT/ADVANCE/ AUDCO/ L&T /KARTAR/INTERVALVE/ LEHRY
5.	NON-RETURN VALVE	ZOLOTO/LEADER/SANT/ADVANCE/ KARTAR/ LEHRY
6.	PRESSURE GAUGE	BAUMER/ HD FIRE /H GURU/FIEBIG/ WIKA
7	FILTER REGULATOR	FESTO/ NORGREN OR EQUIVALENT

2.0 VENDOR APPROVAL PROCEDURE

- a) It shall be obligatory for the Contractor to obtain Notice of No Objection from the Employer for the selection of the vendors for all items of work in accordance with the Technical Specifications and Standards specified in the Contract.
- b) The contractor shall ensure the correct selection of the make meeting the specifications and its application. Before placing the order for procurement, the sample of approved make for applicable items shall be verified for its suitability to the specification and application. In case Employer (whose decision will be final and binding on both parties) considers that the make/ model proposed by the contractor does not meet the tender requirement, the contractor will be required to propose an alternative make acceptable to the Employer.
- c) Vendor to be selected who are capable to provide good after sales services available in Chennai during DLP and thereafter.
- d) The approval of any equipment or product to be used shall be done in two stages: -
 - i. Stage-I
 - Assessment of capability of proposed Vendor to supply a particular equipment or product, with quality and performance requirements, as required by Specifications as well as other contract conditions. The proposed product should be a proven product in service for at least 5 years
 - Assessment of the financial and functional strength of the Vendor to supply the requisite quantity of equipment and product as per delivery schedule acceptable to contractor and Employer to deliver the project in time
 - ii. Stage-II
 - Stage-II called as Technical Submission Approval Stage, selection of Equipment or product from the equipment / products manufactured / supplied by the proposed vendor will be done. This stage includes thorough technical
 - Assessments about the conformance of the offered equipment / product to the Specifications and other requirements.
- e) To obtain proposed Vendor Approval the Contractor must apply with the four sets of the following documents to the Employer
 - i. Company Profile and Experience of the Vendor
 - ii. Clause wise compliance of the relevant Clauses of Specifications with seal and sign of OEM/Vendor.
 - iii. Details of supplies / orders executed in last ten years for the type of equipment /product offered. Supplies / orders executed for Elevated / Underground Metro / DEPOT Systems shall be specifically mentioned
 - iv. Details of the facilities available at the Works / Manufacturing Unit where the proposed equipment / product shall be manufactured.
 - v. ISO 9000 Certification for the Works / Manufacturing Unit where the proposed equipment / product shall be manufactured (The Works / Manufacturing Unit

- where the proposed equipment / product shall be manufactured must have ISO 9000 Certification)
- vi. Proof regarding compliance to Manufacturer's Qualifications. The offered products must be proven in service
 - vii. BIS Certification / CE / UL / FM / AMCA etc., not limited to as applicable for the proposed product.
 - viii. Type test certificates from accredited laboratories for the proposed type of equipment / products to establish the technical capability of the vendor (In case, specific requirements are mentioned in the relevant sections of Specifications with regard to type testing, same shall also be complied additionally). For type tests, the contractor can provide test reports performed according to the corresponding standards at an NABL accredited third party Test Laboratories, on similar equipment of same capacity and design but the same should not be more than five-year-old. If the Type test reports are more than five years old, the same should have been revalidated again by NABL accredited third party Laboratories
 - ix. Vendor shall not have been blacklisted by any Govt. Agency in India.
 - x. Any other item as required by Employer.
 - xi. Contractor shall provide certificate of satisfactory performance after sales service, if they have supplied similar materials to any of the CMRL projects. Where similar System/ Sub-systems of a different rating are already proven in service as per the above criteria then the supply shall be based on such sub-systems.
 - xii. Contractor must certify the check list provided that vendor Proposal is complete and all the above documents are available in the Vendor Proposal. In addition, the Contractor must check / certify compliance to the Specifications before forwarding the same.
 - xiii. Incomplete Vendor Proposal will not be treated as a submission for review and will be returned with rejection status.
 - xiv. Technical submission shall be accompanied with the calculations / other technical documents to justify the selection of any particular model of equipment / product, detailed technical features / parameters of the selected product, type test certificates from the accredited laboratories for the offered products, any other document required by the Employer.
 - xv. Employer will give Approval to the Vendor Proposal (received complete with all the documents mentioned above) expeditiously.
 - xvi. If the Technical Proposal submitted is not acceptable to the Employer, the Contractor must propose alternate make/vendor within 14 days of time (From the date of Rejection).
- f) It may be noted that approval of vendors as per procedure above shall only be done by Employer after the award of the work. Vendor submissions shall not be evaluated during the tender evaluation. Conditional Tender offers received from

Tenderers with particular vendors for supply of equipment/ products will not be evaluated during evaluation and will be dealt with after award of the work.

- g) It may further be noted that Employer shall be under no obligation to accept equipment / products manufactured by the successful Tenderer, unless it meets the entire criterion mentioned above.

(h) Additional points

In addition to above, the following shall also be ensured for the Vendor Approval and Selection: -

(i) Systems and Sub-Systems

- Manufacturer shall have at least 5 years' experience of design and manufacturing of similar system. Proposed systems from the proposed manufacturing unit shall have been in use and have established their satisfactory performance and reliability for 3 years in minimum.
- All sub-systems, equipment's and major components etc. (Hereinafter referred as 'sub- systems') shall be state-of-art and of proven design.
- Proposed Systems/ sub-systems shall have been in use and have established their satisfactory performance and reliability on at least Two mass rapid transit systems (including Railway or Airports) in revenue service over a period of three years or more either outside the country of origin at an average in two different countries or in CMRL. Systems/ Sub-systems/ components used in CMRL do not get automatically qualified for use unless specifically Approved by the Employer for this project. If required by the Employer, Contractor shall provide certificate of satisfactory performance and after sales service for a period of five years or more from the Metro operators. In addition, Contractor shall provide certificate of satisfactory performance and after sales service if they have supplied similar materials to any of the CMRL projects Where similar System/ Sub-systems of a different rating are already proven in service as per the above criteria then the supply shall be based on such sub-systems.
- All 'sub systems' shall be procured from the Indicative/Used vendors and sourced from only such manufacturing units that have supplied the sub-systems that fulfil the proven design requirements as above.
- In case the contractor proposes to use systems or sub-system(s) that do not fulfil the above said criteria then the contractor shall furnish sufficient information to prove the basic soundness and reliability of the offered systems and sub-system(s) for review of the Employer.
- The Employer's decision on contractor's proposal shall be final and binding.

(ii) For sourcing the equipment from indigenous manufacturing facilities, following conditions shall be complied: -

- In case the vendor uses his own facilities for indigenization after part supply of equipment from the Indicative/Used manufacturing unit, no change in

design, component type/make, quality standards, manufacture procedure etc. shall be made without specific approval of the Employer.

- In case OEM wants to use manufacturing facilities in India (other than his own) for items for which the OEM has been Approved, it shall enter into an agreement with such selected Indian equipment manufacturer and obtain prior approval from CMRL. No change in composition, rating, type, model no., manufacturing process, quality standards, design, etc. and make of the components used in assemblies/sub-assemblies of such equipment as manufactured by the Approved parent vendor shall be made without specific approval of the Employer.
- In case OEM wishes to change/make/type specifications, etc. of any sub-components for supplies to be sourced from Indian facility, specific prior approval of the Employer shall be obtained for changes made, model, specification, etc. Responsibility for obtaining such prior approval shall rest solely with the contractor.
- Format for submitting the vendor approval request shall be given to the contractor during initial stages and Approved format shall be followed throughout the contract.

3.0 TESTING AND INSPECTION

(a) General

- (i) As part of the preliminary design submission the contractor shall submit to the Employer and the Engineer for acceptance a schedule of test giving full details of all tests to be carried out.
- (ii) Test at place of manufacture to be witnessed by the Employer and the Engineer shall be grouped together so far as can be arranged so that as many tests as possible can be witnessed on each visit.
- (iii) The contractor shall make his own arrangement for "The Employer and the Engineer" factory visit including travel, boarding and lodging for every FAI (First Article Inspection) if necessary, as required by the Employer except for FAT. For FAT, please refer section VI A, chapter 9, clause 9.1.4 and 9.1.5
- (iv) The contractor shall perform all applicable test specified in these specification as per the relevant standards. Any test required as per the applicable safety standards but not specified in this specification shall be performed without any extra cost to CMRL.

- (v) The contractor has to take the EIG (Electrical inspector to Government) approval of the E&M installation before commissioning of the same. The contractor has to comply with all the requirements for the EIG inspection, make the necessary application and should make all the arrangement, conduct test and submit the required compliance certificate necessary for the approval. The application should be submitted with approval of engineer in charge.

(b) General requirement for type test and acceptance tests.

- (i) The tender shall provide details of any type and acceptance test, which have been carried out on equipment offered, or any additional tests recommended.
- (ii) In general, certificates of previous type test may be accepted at the discretion of the Employer and the Engineer provided that they are for identical equipment's and condition. Where appropriate, new and or modified components to meet the equipment's of this specification shall be made available for type testing.
- (iii) All applicable types tests as per the relevant standards on equipment's shall be carried out strictly as specified in the specifications and procedure of testing shall be submitted to the Employer and the Engineer for No objection.
- (iv) The Engineer shall have right to witness test and inspections on individual materials components, or sub-assemblies, and details of these shall be agreed between the contractor and the Employer and the Engineer
- (v) At the conclusion of all type tests, the contractor shall compile all the test data together with any observations made during the test, file them into a type test binder and submit it to the "the Employer and the Engineer" for acceptance and record.

(c) General requirement for test during manufacture

- (i) The manufacture shall carry out all applicable tests during manufacture as specified and propose any additional tests to be carried out as per relevant standards. These tests shall be subject to the acceptance of the "the Employer and the Engineer". Routine tests shall be integrated with the manufacturing programme. The Employer and the Engineer" will, at his discretion, witness the routine tests during the period of manufacture, or accept the records of the manufacture in-house quality control scheme, where appropriate, as sufficient evidence for the execution of the routine tests.
- (ii) Routine tests shall be carried out strictly as specified in the test specification

- (iii) On Completion of the manufacture of items or sub-assemblies and following completion of the manufacture's own tests and inspection, the "the Employer and the Engineer shall be invited to witness such tests as he deems appropriate. The contractor shall schedule the routine tests to meet the manufacturing programme, whether or not the Employer / Engineer will be present at the tests, provided advance notice has been served to the Employer and the Engineer" in accordance prior information's.
- (iv) The engineer will determine and advice the contractor of those test where certifications by the manufacturer may be acceptable in lieu of witnessed tests
- (v) Before equipment is dispatched, Employer / Engineer will signify his acceptance by signing certificates releasing such equipment from the place of manufacture or test.
- (vi) Methods of packing and shipping shall be as specified in the Employer's requirements, the Engineer reserves the right to visit the manufactures or packer's premises to ensure that accepted method are employed.

(d) Test specification.

- (i) The contractor shall submit for acceptance by the Employer and the Engineer test specifications for the type tests, routine test, on site final acceptance tests and commissioning. The specifications shall detail the methods of conducting the test, the tool and instruments used. Reference to the accepted documents and drawing shall be included in these specifications. The record/results shall be tabulated in a prescribed format applicable to this contract.
- (ii) Nothing in this specification shall prevent the Employer and the Engineer from calling for extra tests.
- (iii) These test specifications shall include the design value of all quantities to be verified, with allowable tolerance or limits. Summary drawings or diagrams shall be included with test specifications to show the dimensions and tolerances of all structural assemblies and sub-assemblies. In the case of welded fabrications, key diagrams giving all weld data shall be provided to enable systematic inspection to take place.

- (iv) Verification of accuracy shall be required for all tools, apparatus, testing jigs, measuring instruments and 'Go' or nogo gauges used for purpose of routine tests.
- (v) All test instruments shall be calibrated not more than one year prior to their use. The contractor shall submit calibration certificate or other documents for proof of compliance.

(e) Testing of materials and details.

- (i) Where materials or components used in this contract are not covered by separate test specifications, samples of such materials or up to 2 % of such components shall, if desired by the Employer / Engineer be tested at the contractor's expense an approved laboratory.
- (ii) The contractor shall supply the material required for testing free of charge and shall supply and prepare the necessary test pieces, labour and appliance for making all tests, and for carrying out all gauging and weighing on this premises in accordance with the terms of this specifications. If the contractor is unable to provide approved facilities at his own factory for making the prescribed test, the contractor shall bear the cost of carrying out the test elsewhere, at place subject to the Employer and the Engineer acceptance.
- (iii) Such radiographic examination of welds or casting as the Employer/Engineer deems necessary shall be carried out.

(f) Interface and integrated tests.

The contractor shall co-ordinate and carry out interfacing and integrated testing together with other system – wide contractor to ensure that the integrated system function as desired. The integral testing and commissioning will be carried out with other system contractor not limited to traction contractor, S&T contractor, etc. The contractor has to interface with all the contractors to get the test done. The system shall be taken over only after the completion of the integral testing & commissioning done at all the stations of the schedule/section.



CHENNAI METRO RAIL LIMITED
CHENNAI METRO RAIL PROJECT PHASE 2 CORRIDOR 4
TENDER No. C4-E&M-05

Supply, installation, testing commissioning and training of Electrical, Fire protection and VAC works for 18 Elevated stations from Power House Station to Poonamallee Bypass station including Viaduct between the stations (Ch 10027.102 to Ch 25928.186), approach ramp, including Poonamallee Depot for Corridor 4 of Chennai Metro Rail Project Phase-II

PART – 2
EMPLOYER’S REQUIREMENTS
SECTION VI A
APPENDIX – 12
IS & CYBER SECURITY TECHNICAL
REQUIREMENTS

MARCH 2022

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12.1. Introduction

- 12.1.1 All references in this document to clauses or Appendices of the Agreement are intended and shall be deemed to be references to clauses and Appendices of the Agreement document.
- 12.1.2 In this document, capitalized words or phrases shall have the meaning ascribed to them in the Agreement (Definitions).
- 12.1.3 Any capitalized words, terms, phrases, or abbreviations used or explicitly defined in any clause, section, paragraph, or article of this document shall have the meaning set forth therein.
- 12.1.4 Where such words or phrases are not capitalized, they shall have the meaning consistent with the context.
- 12.1.5 This document is incorporated into and constitutes and forms an integral and substantive part of the Agreement. Without derogating from the foregoing, this document should be read in conjunction with all Agreement documents.
- 12.1.6 This document does not describe all obligations or responsibilities of the Concessionaire in respect of the execution of the Chennai Metro Project pursuant to the Agreement. Nothing stated or contained or not stated or not contained in this document shall limit or derogate from any of the Concessionaire's duties, obligations, and responsibilities under and pursuant to the Agreement and Law.

12.2. Scope and General Provisions

- 12.2.1 The Systems and Information Technologies (IT) of the Chennai Metro Project collects and processes a variety of digital information, including safety-critical and sensitive information. throughout the Chennai Metro Project, the Concessionaire shall implement measures to protect information and the supporting systems from unauthorized access, modification, destruction, whether accidental or intentional, and to ensure authenticity, integrity, and availability of the information systems.
- 12.2.2 For the purpose of this document:
- 12.2.2.1 Information Technology (IT) assets shall be deemed to include all of the following: information and communication technology systems, including computer systems, Industrial Control Systems (ICS) and SCADA, network and security devices, assets which process, store, transmit or monitor digital information, and all other systems mentioned in this Chapter.
- 12.2.2.2 Information Security is a series of means and measures implemented with respect to all Metro systems in order to protect the information processed, stored, and transmitted by the Metro System. In addition, it covers the security of information technology facilities and off-site information storage, computing, telecommunications, and applications related services and connectivity.
- 12.2.2.3 Information Security consists of several security services: communications security, data security, software security, operations security, and technological means.
- 12.2.3 For the purpose of this Chapter and the Information Security requirements, the “Gartner Magic Quadrant” referred to herein pertains to publications from FY2021 and onwards at www.gartner.com “Gartner Magic Quadrant” research notes.
- 12.2.4 Reference in this Chapter is made to security-related procedures and requirements of CMRL and any other relevant Authority. Notwithstanding any such specific references, the following shall apply:
- 12.2.4.1 The Concessionaire is responsible for complying with and implementing all conditions imposed by or pursuant to the procedures and requirements of CMRL or any other Authority.

- 12.2.4.2 Such procedures and requirements and/or the conditions for their fulfillment may be amended or updated from time to time, and CMRL, and/or any relevant Authority may, at their discretion, issue or impose any number of additional modified and/or replacement procedures, requirements and/or conditions (including, inter alia, as per the provisions of Sections 12.6.11 ,12. 6.12 & 12.6.13 Qualified Personnel) below. The Concessionaire shall comply with any such updates and amendments.
- 12.2.4.3 Notwithstanding that security-related risks are not always predictable, and notwithstanding that security-related considerations, means, methods, and/or solutions are constantly developing and evolving, the Concessionaire shall be deemed to have evaluated, assessed, and taken into account all risks and costs associated with complying with its security-related obligations under and pursuant to such procedures and requirements, the Agreement and Law.
- 12.2.5 The provisions of this Chapter are neither intended nor shall be construed as limiting or derogating from the Concessionaire's obligations to comply with and implement any and all applicable Laws, Permits, and requirements of applicable Authorities, whether in respect of security-related matters or otherwise.
- 12.2.6 This document establishes the minimum requirements for the Information Security System (ISS) for the Metro System with the goal of protecting the data availability, integrity, and confidentiality of Metro System computing and information systems.
- 12.2.7 The document also includes Information Security requirements pertaining to other Work Packages covering communication and systems in the Chennai Metro Project. The Concessionaire shall take these into consideration in the design and execution phases.
- 12.2.8 This document addresses the minimal security considerations and measures in the following areas:
- a) Authentication and identification
 - b) Authorization and access control
 - c) Network security
 - d) Data security
 - e) Security architecture
 - f) Security administration
 - g) Network devices
 - h) Server, host and end-point security
 - i) Application and database security
 - j) Audit and monitoring
 - k) System availability and continuity
 - l) Physical security

12.3. Reference Documents and Standards

12.3.1 Applicable Laws and Standards

The Concessionaire shall design in compliance with all applicable laws and standards, including the standards specified below.

Standard	Description
EN 50159	Railway applications – communication, signalling and processing systems. Safety-related communication in transmission systems
EN50125	Railway applications – environmental conditions for rolling stock and on-board equipment.
FIPS -140	U.S. government computer security standard for the accreditation of cryptographic modules
IEC 62443	Industrial Communication Network – IT Security for Networks and Systems
ISO 27001:2013	Information Technology - Security techniques - information security management systems
NIST SP 800-125	Guide to Security for Full Virtualization Technologies
NIST SP 800-30	Guide for Conducting Risk Assessments
NIST SP 800-53	Recommended Security Controls for Federal Information Systems and Organizations
PCI DSS	Payment Card Industry Data Security Standard
TS 50701	Railway Applications – Cyber Security

The P-SCADA and F-SCADA shall comply with the following Information Security standards:

Standard	Meaning
IEC 62443	Industrial Network and System Security
FIPS 140	U.S. Government Computer Security Standard for the Accreditation of Cryptographic Modules
NIST SP 800-82	Guide to Industrial Control Systems (ICS) Security
NIST 800-125	Guide to Security for Full Virtualization Technologies

12.4. Acronyms, Abbreviations

In this document, the following abbreviations shall have the meaning ascribed thereto hereunder:

Acronym	Meaning
AAA	Authentication, Authorization and Accounting
ACL	Access Control Lists
ACN	Administrative Communication Network
ACS	Access Control System
AD	Active Directory
AES	Advanced Encryption Standard
AFC	Automatic Fare collection
ATS	Automatic Train Supervision
AV	Anti-Virus
BIOS	Basic Input / Output System
C&C	Command and Control
CBN	Communication Backbone Network
CBTC	Communications Based Train Control
CDR	Content Disarm and Reconstruction
CI/CD	Continuous Integration / Continuous Delivery
CSOC	Cyber Security Operation Center
DALC	Data Access Layer Component
DCC	Depot Control Center
DDoS	Distributed Denial of Service (attack)
DHCP	Dynamic Host Configuration Protocol
DID	Defense-In-Depth
DLP	Data Leak Prevention
DMZ	Demilitarized Zone
DNS	Domain Name System
DPI	Deep Packet Inspection
DR	Disaster Recovery

Acronym	Meaning
DRP	Disaster Recovery Plan
ECMP	Equal-Cost MultiPath
EDR	Endpoint Detection and Response
F&EN	Fire & Emergency Network
FIPS	Federal Information Processing Standards
FW	Firewall
HMI	Human Machine Interface
HW	Hardware
ICS	Industrial Control Systems
IDS	Intrusion Detection System
IMS	Incident Management System
IP	Internet Protocol
IPS	Intrusion Protection System
IPSEC	Internet Protocol Security
ISA	International Society for Automation
ISS	Information Security System
LAN	Local Area Network
MAC	Media Access Control
MDM	Mobile Device Management
NAC	Network Access Control
NAT	Network Address Translation
NDAA	National Defense Authorization Act
NIST	National Institute of Standards and Technology
NMS	Network Management System
NOC	Network Operation Center
OCC	Operation Control Center
OCN	Operational Communication Network
OTP	One Time Password

Acronym	Meaning
OWASP	Open Web Application Security Project
PAS	Public Announcement System
PBX	Private Branch Exchange
PKI	Public Key Infrastructure
PLC	Programmable Logic Controller
PSIM	Physical Security Information Management
PSTN	Public Switched Telephone Network
PT	Penetration Testing
PTO	Permit to Operate
QoS	Quality of Service
RBAC	Role Based Access Control
RMCS	Radio Mobile Communication System
ROIP	Radio over Internet Protocol
RPF	Reverse Path Forwarding
RSS	Railway Scheduling System
SAM	Security Account Manager (MS Windows)
SCADA	Supervisory Control and Data Acquisition
SCN	Signalling Communication Network
SDLC	Software Development Lifecycle
SHA	Secure Hash Algorithm
SIEM	Security Information and Event Management
SM	Sparse Mode
SMS	Short Message Service
SOC	Security Operation Center (physical)
SQL	Structured Query Language
SRA	Secure Remote Access
SSH	Secure Shell
SSL	Secure Sockets Layer

Acronym	Meaning
SW	Software
TBS	Time Based System
TCC	Temporary Control Center
TCMS	Traffic Control Management System
TD	Train Detector
TLC	Traffic Light Controller
TLCN	Traffic Light Communication Network
TLS	Transport Layer Security
TPM	Trusted Platform Module
TTR	Trackside Technical Room
UPS	Uninterrupted Power Supply
VLAN	Virtual Local Area Network
VoIP	Voice Over Internet Protocol
VPN	Virtual Private Network
WCDS	Wireless Communication Depot System
WWRS	Wideband Wireless Radio System

12.5. Project IT Infrastructure Overview

12.5.1 The Metro System IT infrastructure shall be implemented based on physically and logically autonomous environments including:

- a) SCN (Signalling Communication Network)
- b) OCN (Operational Communication Network)
- c) ACN (Administrative Communication Network)
- d) F&EN (Fire and Emergency) Network
- e) Traffic Light Communication Network (TLCN)

12.5.2 The administrative systems and applications shall be provided by the Concessionaire. The security solution shall be designed and implemented with all the security means to be ready to absorb the administrative systems, including interfaces to other environments.

12.5.3 As part of the desired functionality and services, some of these core networks shall be expandable and shall provide interconnectivity with external service provider networks and institutions via direct links or dedicated network segments. Implementation decisions for the external connectivity shall follow the security guidelines, as defined in the following security requirements.

12.5.4 The Traffic management is composed of three (3) standalone networks physically and logically separated from the CBN:

- a) TLC communication network.
- b) TD communication network.
- c) Traffic VSS / CCTV communication network.

12.6. General Requirements

- 12.6.1 The Concessionaire shall ensure that the Information and cyber security control measures architecture shall comply with the provisions of this Chapter.
- 12.6.2 The Concessionaire shall ensure that the information and cyber security concept as detailed in chapter 12.8.2 is implemented in compliance with all applicable Laws and standards.
- 12.6.3 The security measures shall address the independent and disparate environments in the Chennai Metro Project as described above.
- 12.6.4 The Concessionaire shall deliver the technical infrastructure necessary to integrate security controls. This infrastructure shall be consistent with the security technologies as defined herein.
- 12.6.5 The Information Security solution shall focus on enhancing the business practices and procedures that are being utilized by the Metro System and should not be the driving force for the Metro System's business practice and procedures flow.
- 12.6.6 The Information Security controls and products shall be adapted to meet all other requirements of the Agreement, and as such, shall support the necessary SCADA protocols. The software and hardware components shall be manufactured by companies listed as leaders 1-4 in the Gartner Magic Quadrant.
- 12.6.7 The proposed security infrastructure shall provide the needed functionality with as little impact as possible upon the Metro System. The solution shall cover all risks presented in the Concessionaire Initial Risk Analysis.
- 12.6.8 The proposed solution shall have the potential to be scaled in the future, to enable straightforward integration of additional acquired resources into the system. Horizontal and vertical scalability of the solution is required to enable the future expansion of the proposed solution to accommodate a broader range of users.
- 12.6.9 During implementation, the Concessionaire is required to develop, maintain and update the Information Security policy and procedures.
- 12.6.10 An Information Security Manager for the Metro System shall be appointed by the Concessionaire. The Information Security Manager shall maintain ongoing contact with CMRL, and shall be responsible, on behalf of the Concessionaire (and without derogating from the Concessionaire's responsibilities and obligations) for the implementation of the Information Security requirements and for ensuring they are followed. The Information Security Manager shall be approved in advance by CMRL. The CHENNAI Metro Project's Information Security Manager shall monitor the level of Information Security in accordance with the requirements defined by CMRL. See additional requirements in section 12.7.2.
- 12.6.11 Without derogating from the requirements of– Security and Emergency Preparedness Policy, all personnel involved in the Design, Construction (including implementation, installation, Testing and Commissioning) and Maintenance of mission critical systems in the Metro System (such as, for example, [signaling and CBTC, SCADA, Communication & IT systems and Security Systems), shall undergo security clearance and reliability checks in accordance with the procedures of CMRL (as amended or updated from time to time).
- 12.6.12 Only personnel so qualified, following security clearance and reliability checks, shall take part in the Design, Construction (including implementation, installations, Testing and Commissioning) and Maintenance of mission critical systems (“Qualified Personnel”).
- 12.6.13 Qualified Personnel may, from time to time, be required to re-qualify and/or undergo periodic or additional security reliability checks in accordance with the procedures of CMRL (as amended or updated from time to time).

- 12.6.14 Without derogating from the generality of the provisions of Section [2] (Scope and General Provisions) above or of the foregoing, updates or amendments to the procedures of CMRL may apply, inter alia, to: (i) the definition of “mission critical systems”; and (ii) the level of security clearance required with respect thereof.
- 12.6.15 According to the instructions of Security and Emergency Preparedness Policy, the Concessionaire shall prepare itself to manage cyber security incidents, including training and mobilizing an Incident Response (IR) team and a negotiation team (in the event of a ransomware incident) that specialize in managing such incidents, and which shall be managed by the CSOC. These teams shall provide on-site and off-site response, depending on the characteristics of the and emergency.
- 12.6.16 Remote access to the Metro System shall be possible only via VPN secured and authenticated communication.
- 12.6.17 Anti-malware, anti-spam, anti-spyware, etc. software shall be installed on all computers.
- 12.6.18 Personal Firewalls shall be installed on Workstations.
- 12.6.19 Laptop disks shall be encrypted.
- 12.6.20 All servers and Workstations shall be hardened.
- 12.6.21 Equipment Power Supply
- A. Power supply
 - i. The equipment shall operate on a voltage of 230VAC 50Hz, unless defined otherwise.
 - ii. Equipment that supports redundant power supply shall support power intake from two different power supply sources.
 - iii. Redundant power supplies shall be used as required.
 - B. Power supply interruption & UPS (Uninterruptible Power Supply)
 - i. The proposed ISS, including all related equipment, both in the OCC and at the DCC/TCC, shall be connected to an Uninterruptible Power Supply (UPS) that shall provide backup power to the equipment housed at each site.
 - ii. UPS requirements for all subsystems equipment including ISS equipment is described in Communication Systems .

12.7. Project Management Arrangements

12.7.1 Local Contractors and Qualified Personnel

- A. The ISS scope of work, including all its components – planning and design, procurement, integrating, testing, operation and maintenance – shall be fully executed by a local national sub-contractor employing personnel with security certification/s (“Qualified Personnel”), valid during the period of activity associated with the project, as indicated above.

12.7.2 Concessionaire’s Cyber Security Professional Team

- A. **Concessionaire personnel dedicated to cyber security.** The Concessionaire shall recruit and employ dedicated professional personnel to handle cyber security issues throughout all project phases (planning and design, assimilation, operation and maintenance). The dedicated professional personnel shall include the following:
 - a. CISO – Chief Information Security Officer, a Concessionaire employee working full-time, with valid security certification/s. The CISO shall

provide professional guidance and support to the contractors and sub-contractors acting on the Concessionaire's behalf. He shall be responsible for the following:

- i. Assimilating the Information Security and cyber protection requirements, as detailed in the ISS Requirements document.
 - ii. Writing an Information Security master plan, as well as security procedures for the planning, design and establishment phase of the project, and security procedures for the operation and maintenance of the Metro system.
 - iii. Leading the Information Security and cyber protection setup throughout all phases – planning and design, procurement, installation, integration, testing, operation and maintenance.
- b. Qualifications required of the CISO
- i. The following valid certificates – CISO, CISSP, CISM, CISA, CSSA or equivalent.
 - ii. More than 5 (five) years of experience in managing Information Security in National and international projects, including supporting specifically in Information Security and cyber protection aspects in the planning and design, procurement, installation, integration, testing, operation and maintenance phases.
 - iii. Extensive knowhow in the protection of IT and OT infrastructures and systems.
 - iv. In-depth familiarity with up-to-date technologies and Information Security regulation pertaining to the field of transportation.
- c. The CISO shall undergo an interview and shall be appointed pending the approval of CMRL.
- B. Additional personnel dedicated to cyber security.** The providers of the **following** systems and disciplines shall each appoint an Information Security lead:
- a. Rolling Stock.
 - b. Signalling and Train Control.
 - c. Communication and Data Center.
- C. The areas of responsibility of the above providers' Information Security leads** include:
- a. Managing the Information Security and cyber protection aspects in the providers' offices, to provide and ensure a safe and secure project work environment.
 - b. Implementing the guidelines dealing with the providers' areas of responsibility and reporting to the organizational CISO on a regular basis.
 - c. Managing the design, installation, assimilation and operation of the Information Security System (ISS) components associated with their activity and scope of work.

- D. The qualifications required of the sub-contractors' Information Security leads for the systems mentioned above are:
 - a. A following valid certificates – CISO, CISSP, CISM, CISA, CSSA or equivalent.
 - b. More than 3 (three) years of experience in managing Information Security in projects that include IT and OT infrastructures and systems.
- E. The CISO, together with the providers' Information Security leads, shall comprise **the** Concessionaire's Information Security team throughout all phases of the Chennai Metro Project.

12.8. General Information Security Requirements

12.8.1 General Requirements

- A. The Cyber Security Management Plan and cyber security procedures shall be **prepared** and provided to CMRL for approval during the Development Phase. Without derogating from the generality of the provisions of the Agreement, the Cyber Security Management Plan and cyber security procedures shall comply with CMRL's guidelines.
- B. The proposed system and security architecture shall be designed according to the Concessionaire's Information Security risk assessment and cyber **security** risk management plan.
- C. The necessary measures to protect the availability, integrity and confidentiality of the **data** shall be undertaken.
- D. The security controls shall be based on open architecture standards and shall support a distributed computerized environment.
- E. The security controls shall be scalable and capable of being configured to accommodate different levels of security per environment, user, application, or per endpoint basis.
- F. The proposed products for the entire systems (Including IT infrastructure, networking and security, P-SCADA, F-SCADA, VSS, TBS, etc.) shall conform to the requirement specified herein).
- G. As a rule, the installation of any HW / SW manufactured / produced by a blacklisted company / provider, such as in the US government's National Defense Authorization Act (NDAA), or concerning whom there are official intelligence reports suggesting / indicating exploitation of HW / SW manufactured / produced by it for the purpose of penetrating IT infrastructures, will be prohibited.
- H. The security architecture shall provide the capability to track, record and monitor successful and unsuccessful interactions with all Project Systems and subsystems.
- I. The architecture shall examine the issue of segmentation according to the principle of access authorization.
- J. The infrastructure shall incorporate secure data exchange mechanisms and technologies such as cryptography, key management, access control, authentication, and data integrity, where appropriate.
- K. Activities related to Information Security shall be dynamic. The goal is the compartmentalization and control of information distribution to authorized

parties only and as needed, while reducing the impact of internal and external security threats on the IT infrastructure.

- L. A Software Development Lifecycle (SDLC) process shall be implemented throughout the Chennai Metro Project as part of the ISS design and integration, including CI/CD processes, in accordance with CMRL's guidelines.
- M. A Data Leak Prevention (DLP) technology, as well as a DLP procedure policy, shall be completed and provided to CMRL for approval.

12.8.2 Information and Cyber Security Concept -Defense-In-Depth (DID)

- A. The general objective of defense-in-depth (DID) is to ensure that a single failure, whether equipment failure or human failure, at one level of defense, and even combinations of failures at more than one level of defense, would not propagate to subsequent levels. The independence of different levels of defense is a key element in meeting this objective.
- B. Infrastructure shall be based on implementation of the Defense-In-Depth (DID) concept of a hierarchical deployment of different levels of security controls and procedures in order to maintain the effectiveness of the security solution.
- C. The DID concept shall be implemented through design and operation to provide graded protection against a wide variety of security events, incidents and accidents, including human errors within the Metro System and events initiated outside the Metro System.
- D. ISS implementation shall rely on DID hierarchical deployment for all levels of security controls and procedures.
- E. ISS DID design shall pertain to correlation, detection and protection measures to impede the progress of a cyber intruder, while enabling the Metro System CSOC/NOC to detect and respond to the intrusion and/or security breach while reducing and mitigating the consequences of a breach by relevant technologies.
- F. The Concessionaire shall provide an interface between the Chennai Metro CSOC (HN CSOC's SIEM) and the CMRL SIEM-SOC. The Concessionaire shall provide, operate and maintain a secure communication medium between Chennai Metro's CSOC and the CMRL SIEM-SOC. The communication and solution and interface required the prior approval of TIS and CMRL.
- G. The ISS DID supporting architecture and products shall address security layers, such as data, application, host, network and perimeter.
- H. For each layer, the following shall be addressed as part of the ISS: Network segmentation; Demilitarized Zones (DMZ); Intrusion Detection System (IDS); Intrusion Prevention System (IPS); Virtual Private Network (VPN); Firewalls (hardware/software); AV/Anti-malware software; Authentication and password security; Encryption; Sandboxing; Hashing passwords; Timed access control; Logging and auditing; Multi-factor authentication; Vulnerability scanners; Physical security (VSS), Central control (NOC, CSOC, SIEM); Audits and logs, Policies; cyber security procedures, including change management.

12.8.3 Data Leak Prevention (DLP)

- A. DLP technology shall be examined based on the criticality level of the information and data that reside in each of the networks.
- B. The ISS shall implement and deploy strong DLP technology products.
- C. DLP shall pertain to the CBN (data-in-motion) analysis of data traffic, to detect sensitive data sent in violation of Information Security policies. DLP shall be centralized, with distributed agents.
- D. Endpoint (data-in-use) agents or clients shall run on internal end-user Workstations and DC servers. End point shall be used to control information flow between groups or types of users.
- E. DLP shall include data identification techniques, to identify confidential or sensitive structured data in fixed fields within a file or unstructured data, to support content analysis, and contextual analysis
- F. The DLP shall pertain to retention and archived data-in-use and data-in-motion.

12.8.4 Building Blocks of the Information Security System (ISS)

- A. Prevention – execute all applicable measures to prevent the Metro System’s security risk.
- B. Detection – detect and identify in real time unauthorized and illegal activities in the Information Systems.
- C. Response and mitigate – response and mitigate security events.
- D. Audit – execute an accurate and detailed audit on all Information Systems activities.

12.8.5 Information Security and Supply Chain Risk Management Requirements

A. General

- a. The Concessionaire shall comply with the Information Security requirements of CMRL, which obligate it to implement several actions, as detailed below.
- b. The Concessionaire shall submit official documents confirming compliance with Information Security requirements, as defined by CMRL.

B. Supply chain risk assessment and risk management plan

The Concessionaire shall implement a risk management plan for the critical systems supply chain , as defined in this chapter, with the following outputs:

- a. A risk assessment for the supply chain shall be conducted for the entire Chennai Metro System and for the following critical systems - ISS, Communication and IT Systems, P-SCADA, F-SCADA, signaling and CBTC and security systems related equipment and systems.
- b. A security management plan for the critical systems supply chain, with specific activities and control measures, shall be completed and submitted to CMRL for approval.

C. Information Security requirements for design outputs

The requirements listed below shall be complied throughout the Chennai Metro Project.

- a. All sensitive digital information (any information that is protected against

- unwarranted disclosure, such as IP schema, low level designs) shall be encrypted.
- b. Sensitive information shall be stored in encrypted and compartmentalized folders, accessed only by users with access authorizations.
 - c. Remote access shall be allowed via VPN secured communication only.
 - d. Anti-malware, EDR, anti-spam, anti-spyware, etc. software shall be installed on all computers.
 - e. Personal firewalls shall be installed on personal computers.
 - f. Laptop disks shall be encrypted.
 - g. The level of Information Security shall be monitored in accordance with the requirements defined by CMRL.
- D. Information Security for sensitive technical documents
- a. The Concessionaire shall fully comply with CMRL procedures for securing and storing digital files.
 - b. Information Security arrangements pertaining to servers used for storing files shall be subject to CMRL's approval, and shall be monitored.
 - c. Access to the server shall be based on access authorizations, and server folders shall be encrypted in accordance with the documents' security classification.
 - d. Sensitive technical documents shall comply with a sensitive Information Security procedure defined by CMRL, that includes access authorizations to folders, password protection and encryption. The printing of these documents and the dissemination of hard copies shall require documenting the recipients and storage in a physically protected location (room with a burglar alarm, a security cabinet or safe).
- E. Procurement of systems' critical elements
- a. The procurement procedure of critical system elements shall follow the CMRL guidelines and shall be subject to CMRL's approval.
 - b. The critical elements (for example, the communication system's software and hardware), shall be purchased from approved providers see clauses 8.5.6. and H below.
 - c. The procurement of critical elements, as well their storage, transport to the site and installation shall be monitored.
- F. Installation, integration, testing and handover of systems
- a. The Concessionaire shall fully comply with CMRL's and its Information Security procedures during the installation, integration, testing and handover of the systems, as well as throughout the Term of the Agreement.
 - b. The procedures shall be developed, implemented and maintained by the Concessionaire.
 - c. Tests shall be executed in accordance with CMRL's and its Information Security procedures, including access control and hardening.
- G. Concessionaire's Requirements by Systems and Activities
- a. The Concessionaire shall be responsible for each project phase

according to the matrix in table 1.

- b. With respect to all of the following (ISS, Communication and IT Systems, P-SCADA, F-SCADA, signaling and CBTC and Security Systems related equipment and systems):
 - i. Only generic hardware and software manufactured by manufacturers listed as “Leaders 1 to 4” in the “Gartner Magic Quadrant” shall be used.
 - ii. If a specific hardware or software component is not listed in the “Gartner Magic Quadrant”, three alternative manufacturers shall be submitted for the approval of CMRL.
- c. In order to ensure a secure supply chain, the Concessionaire shall contract with the local suppliers/branches of the HW and SW components approved by CMRL, and guarantee that the HW and SW components are supplied in India and fully comply with CMRL’s Information Security requirements and CMRL secured supply chain requirements.
- d. CMRL reserve the right to reject a certain HW/SW component. The Concessionaire shall be required to replace a rejected component.

It is hereby clarified that such rejection may be due to the HW/SW characteristics and/or manufacturer / developer / provider, if suspected of non-compliance with Information Security requirements, or it is being suspected of Information Security breaches or illicit activities. For this purpose, CMRL may rely on third party information such as the US National Defense Authorization Act (NDAA), or intelligence reports by any international or local governmental agency.
- e. Qualified Personnel
 - i. Only personnel employed by the Concessionaire or by any of its contractors and/or sub-contractors, who have passed the security clearance checks, shall be considered Qualified Personnel. Only Qualified Personnel shall be permitted to take part in the design, installation, integration, configuration and maintenance of the Critical Systems of the Chennai Metro System.
 - ii. Qualified Personnel may, from time to time, be required to re-qualify and/or undergo periodic confirmations of security clearance or additional security clearance checks in accordance with the procedures of CMRL (as amended or updated from time to time). Please refer also to sections 12.6.11, 12.6.12 and 12.6.13.

H. Systems Requirements

Table 1: Equipment and Qualified Personnel Requirements for Mission Critical Systems

Sub-System	Equipment and System Related Requirements	Personnel Related Requirements	Restricted Access / Additional Requirements
ISS	The provisions of Sections 12.12.8.5.6 b., 12.12.8.5.6.c. and 12.12.8.5.6.d shall	The provisions of Section 12.12.8.5.6 e. above (Qualified Personnel) shall	Only Qualified Personnel on behalf of the Concessionaire shall be provided with

Sub-System	Equipment and System Related Requirements	Personnel Related Requirements	Restricted Access / Additional Requirements
	apply.	apply with respect to all personnel involved in the design, construction, testing, commissioning, operation and maintenance.	access to the ISS for purposes of performing all obligations pursuant to the Agreement with respect thereto.
Communication Backbone Network (CBN)	The provisions of Sections 12.12.8.5.6 b., 12.12.8.5.6.c. and 12.12.8.5.6.d. shall apply.	The provisions of Section 12.12.8.5.6 e. above (Qualified Personnel) shall apply with respect to all personnel involved in the design, construction, testing, commissioning, operation and maintenance.	Only Qualified Personnel operating on behalf of the Concessionaire shall be permitted access to the CBN for purposes of performing all obligations pursuant to the Agreement with respect thereto.
Control Centers & Data Center Systems, include the Staging Environment	The provisions of Sections 12.12.8.5.6 b., 12.12.8.5.6.c. and 12.12.8.5.6.d. shall apply.	The provisions of Section 12.12.8.5.6 e. above (Qualified Personnel) shall apply with respect to all personnel involved in the design, construction, testing, commissioning, operation and maintenance.	Only Qualified Personnel operating on behalf of the Concessionaire shall be permitted access to the Control Center and Data Center Systems for purposes of performing all obligations pursuant to the Agreement with respect thereto.
P-SCADA	a. The provisions of Sections 12.12.8.5.6 b., 12.12.8.5.6.c. and 12.12.8.5.6.d. shall apply; and b. The HMI and the PLCs supplied shall be manufactured (produced) by the same (single) manufacturer; and	The provisions of Section 12.12.8.5.6 e. above (Qualified Personnel) shall apply with respect to all personnel involved in the design, construction, testing, commissioning, operation and maintenance.	Only Qualified Personnel operating on behalf of the Concessionaire shall be permitted access to the P-SCADA for purposes of performing all obligations pursuant to the Agreement with respect thereto.

Sub-System	Equipment and System Related Requirements	Personnel Related Requirements	Restricted Access / Additional Requirements
	<p>c. The Concessionaire shall demonstrate that, as at the date of issuance of Notice to Proceeds, [each of] the HMI and the PLCs supplied are installed and in operational use in not less than three (3) Critical Infrastructure Installations in India</p>		
F-SCADA	<p>a. The provisions of Sections 12.12.8.5.6 b., 12.12.8.5.6.c. and 12.12.8.5.6.d shall apply.; and</p> <p>b. The HMI and the PLCs supplied shall be manufactured (produced) by the same (single) manufacturer; and</p> <p>c. The Concessionaire shall demonstrate that, as at the date of issuance of Notice to Proceeds, [each of] the HMI and the PLCs supplied are installed and in operational use in not less than three (3) Critical Infrastructure Installations in India</p>	<p>The provisions of Section 12.12.8.5.6 e. above (Qualified Personnel) shall apply with respect to all personnel involved in the design, construction, testing, commissioning, operation and maintenance.</p>	<p>Only Qualified Personnel operating on behalf of the Concessionaire shall be permitted access to the F-SCADA for purposes of performing all obligations pursuant to the Agreement with respect thereto.</p>
signaling and CBTC	<p>a. The provisions of Sections 12.12.8.5.6 b. and 12.12.8.5.6.c.</p>	<p>The provisions of Section 12.12.8.5.6 e. above (Qualified Personnel) shall</p>	<p>Only Qualified Personnel operating on behalf of the Concessionaire shall</p>

Sub-System	Equipment and System Related Requirements	Personnel Related Requirements	Restricted Access / Additional Requirements
	<p>shall apply, with respect to all signaling and CBTC equipment, HW & SW components; and</p> <p>b. The Concessionaire shall demonstrate that, as at the date of issuance of Notice to Proceeds, signaling and CBTC equipment, sub-system and SW supplied are installed and are in operational use, in not less than three (3) Metro, Tram-Train, Metro, Rail or Inter-City Rail Projects, with at least 12km and 5 stations in India.</p>	<p>apply with respect to all personnel involved in the design, construction, testing, commissioning, operation and maintenance.</p>	<p>be permitted access to the signaling and CBTC for purposes of performing all obligations pursuant to the Agreement with respect thereto.</p>
Security Systems	<p>a. The provisions of Sections 12.12.8.5.6 b., 12.12.8.5.6.c. and 12.12.8.5.6.d shall apply, with respect to all security systems equipment (edge devices), HW & SW components; and</p>	<p>The provisions of Section 12.12.8.5.6 e. above (Qualified Personnel) shall apply with respect to all personnel involved in the design, construction, testing, commissioning, operation and maintenance.</p>	<p>Only Qualified Personnel operating on behalf of the Concessionaire shall be permitted access to the Security Systems for purposes of performing all obligations pursuant to the Agreement with respect thereto.</p>

For purposes of the foregoing requirements:

- (1) A “Critical Infrastructure Installation” shall mean a large-scale critical infrastructure project in a India, such as a power generation facility, a port, Metro system or an airport.

- (2) “Metro or LRT Project” shall mean a light rail, Metro or commuter rail-based mass transit system in a India providing transportation services to the public.

I. Reporting

- a. The Concessionaire shall comply with the Information Security incident reporting procedures and incident escalation reporting procedures defined by CMRL (as may be amended from time to time), including attempts to penetrate the system, damage caused to components, theft and attempted theft of components that are intended for installation in the Metro System’s critical systems.
- b. The Concessionaire shall implement monitoring and control procedures covering work processes, Design, Installation, Testing and Maintenance of the Metro System’s critical systems, as defined and coordinated with CMRL.

J. Information records and as-made documents

The Concessionaire shall safeguard electronic records, documents and as-made documents in accordance with CMRL guidelines.

12.9. Information Security Threats and Impacts

Figure 1 is an overview of the Metro System’s logical architecture and information flow:

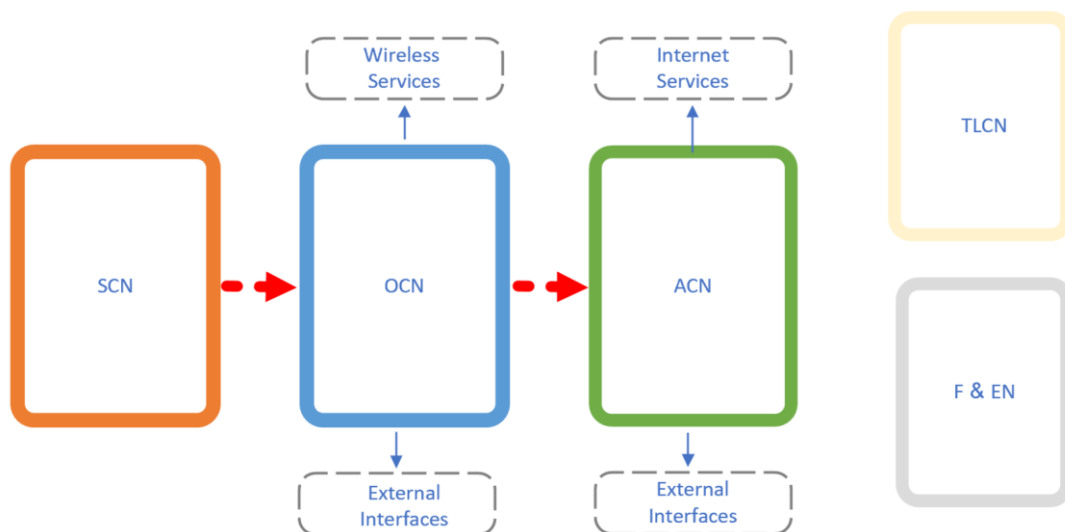


Figure 1: Logical Architecture and Information Flow (Conceptual)

12.9.1 Risk Assessment

The Risk Assessment of the system's security environment shall be conducted by the Concessionaire as described in section 12.14.

The Risk Assessment shall be used as the baseline for the system's security design.

12.9.2 Potential Risk Types

The following non-exhaustive list describes types of security threats related to the Metro System identified during the Initial Risk Analysis:

- a) Impact on the public safety & human lives
- b) Destruction or loss of critical services

- c) Interruption of access to critical services, information or applications
- d) Disclosure or viewing of critical or sensitive information
- e) Modification of critical or sensitive information
- f) Threat prevention and management shall pertain to all known threats at the time of delivery such as the following: Access rate control; Authentication bypass; ARP poisoning; Broken access control; Brute force login; Buffer overflows; Cross site scripting; Cross site request; Denial of Service (DoS); Data Loss Prevention (DLP); Distributed Denial of Service (DDoS); Directory traversal; DHCP spoofing; DNS poisoning; Forms tampering; Hidden field manipulation; Session hijacking; SQL injection; Site reconnaissance; Schema poisoning; XML parameter tampering; WSDL scanning.

12.9.3 Attack Vectors

Threat sources shall be considered including:

- a) Terrorists
- b) Internal attackers
- c) Disgruntled staff
- d) Hackers
- e) Criminals
- f) Foreign intelligence services
- g) Organized crime
- h) Protesters and activists (e.g., environmental, political, animal rights)

12.9.4 Impacts

- a) Safety, health and environmental event or damage to infrastructure: An event that results in harm to individuals, the environment or damage to the infrastructure.
- b) Forced controlled shutdown of operation: An event that results in the emergency shutdown system being automatically invoked with no human intervention, for example, when the view of all or some of the production processes is lost.
- c) Elected controlled shutdown of operations: An event that results in the site electing to shut down its operation, for example, when view of all or some of the production processes is lost.
- d) Reduction in operating efficiency: An event that would result in the system continuing its operation in a less efficient or profitable manner or result in reduced production. For example, operational delays in services provided, or severe environmental change which impacts and limits the ability to use the service.
- e) Loss of business continuity.
- f) Loss of reputation.

12.10. Security Services and Infrastructure

Security Services shall be implemented as part of the Metro System. For detailed security requirements related to individual core networks, refer to Chapter 12.11.

12.10.1 Authentication

- A. The system shall prevent simultaneous logins of a single user.
- B. Users shall be automatically logged off after being idle for 15 (fifteen) minutes.
- C. PKI-based (strong authentication) shall be implemented based on the environment addressed. For the different core network solutions, some of the following methods shall be used: OTP, token, PKI certificate, smartcard, biometric, machine certificates.
- D. The System shall detect the number of consecutive unsuccessful authentication attempts and ignore any authentication attempts when the maximum number of authentication attempts defined by the administrator is reached, i.e., the user account shall be blocked.
- E. Authentication attempts shall only be resumed after the administrator explicitly lifts the restriction, or after a predefined timeout.
- F. A password policy that enforces, as a minimum, strength and complexity of passwords, as well as expiration time, shall be implemented for all systems.
- G. Passwords should be changed frequently. Password history shall be used.
- H. User/service authentication shall be based on individual accounts only. No shared accounts are allowed.
- I. User authentication information shall not be exposed on any output.
- J. No clear text login shall be permitted to any system. The login information shall be cryptographically protected on the network/communications level.

12.10.2 Identification

- A. User identification and authentication shall take place at the network, device, application, and/or device/software level. A user shall be restricted from establishing a secure data exchange without first being identified and authenticated by at least two authentication factors.
- B. The identification service shall be based on a managed directory implemented separately in each one of the System's independent networks.
- C. User groups shall be defined based on administrative units, roles and their functions, with a view to institutionalizing control of access to information.
- D. No default, guest/anonymous, or temporary accounts shall be permitted to any system.

12.10.3 Authorization and Access Control

- A. Security Architecture
 - a. Multi-layered and zone-based network architecture meeting updated industry standards shall be adopted to ensure secure and strong segregation between various environments.
 - b. The various core networks shall be physically separated through a guaranteed one-way traffic mechanism. Logical segmentation for each network shall segregate the internal networks.
 - c. Network segmentation within the various core networks shall be implemented based on the data flow, as will be described in the

- Concessionaire's Initial risk analysis. The segmentation shall be based on firewalls between the network segments.
- d. Further to the network segmentation within the core networks, VLANs, Private VLANs and ACLs shall be implemented for the individual operational services. For example, Directory services shall be in a VLAN, separated and filtered from the DLP services.
 - e. Separation of development, test and production environments is required. Data transfer between environments shall be done in a controlled manner.
 - f. Internet access from/to signalling and operational communication networks shall not be permitted. Any access to the Internet shall be achieved only from the ACN and through terminal based computing (e.g., Citrix).
 - g. Every wireless access network incorporated into the system's infrastructure shall be completely separated from all the core networks and from any other wireless network.
 - h. The separation between the wireless and the core networks shall be obtained on all the levels of system's and include at least a physical separation, Firewall inspection, Dedicated cryptography and VPN tunneling – on the network transport level, communication inspection on the application level. The security measures and architecture of the wireless access networks shall be specifically approved by the CMRL.
 - i. Privileged user access shall be managed with Privileged access management technology.
 - j. The Concessionaire shall authorize, control and monitor access privileges to system and information resources to the following entities:
 - i. **Users (all entities with access to system resources).**
 - ii. **Operations personnel.**
 - iii. **Non-interactive processes.**
 - iv. **Maintenance and support personnel.**
 - v. **Supervisors.**
 - vi. **Systems analysis and programming personnel.**
 - k. The access control mechanism shall be flexible and capable of managing issues such as delegation of rights and changes in roles.
 - l. Role-Based Access Control (RBAC) shall be implemented based on the type of information accessed and in accordance with the user groups defined.
 - m. The information system shall employ the concept of least privilege, allowing only authorized accesses for users, and processes or services acting on behalf of users, which are necessary to accomplish assigned tasks in accordance with organizational missions and business functions.
 - n. User privileges shall be restricted by:

- i. Controlling user read, write, create, delete and execute capabilities.**
 - ii. Implementing access control lists.**
 - iii. Implementing capability lists.**
 - iv. Controlling hierarchical authorization, such as CMRL, group, system and everything else.**
- o. All successful logons and any failed logon attempts shall be logged.
 - p. Network Access Control (NAC) shall be based on IEEE 802.1x or equivalent and shall be implemented for all devices connecting to the system resources and supporting the relevant security protocols. Devices not supporting secure network access technologies should be connected to a separate network segment (physical or virtual [VLAN]), and their access to the network should be protected by a standard network-level security mechanism (such as MAC security), or a dedicated NAC system.
 - q. Inactivity session timeouts shall be implemented for all applicable systems. Automatic termination of expired sessions and re-authentication of interactive users after a predefined period of inactivity shall be enforced.
 - r. The Information System shall limit the concurrent sessions for each System account.

B. Remote Access

- a. Remote connection shall allow the systems providers (controllers, software components) to conduct diagnostics and software updates in the Production environment in cases where the Concessionaire, via the various maintainers, did not succeed to complete local maintenance work and/or update software via a local entity in the Staging environment.
- b. A cryptography mechanism shall be used to protect the confidentiality and integrity of remote access to information system (e.g., VPN).
- c. The Information System shall route all remote access through a limited number of managed access control points.
- d. Remote access shall be restricted to specific users and at specific times.
- e. The execution of privileged commands on mission critical systems and/or access to security-relevant information, via remote access, shall be authorized only for specific operational needs.
- f. In case access is needed by external national authorities (e.g., Police), it shall be based on network extension over a private encrypted secure channel (e.g., dark fiber), and performed from a managed and/or authorized and authenticated client.
- g. Remote access methods to SCN and OCN core networks shall be implemented according to CMRL guidelines, and approved by CMRL.

- h. The need for remote connection to the operational network shall be evaluated, and a structured process to achieve this shall be proposed.
- i. A system supporting the Secure Remote Access (SRA) and the recording of the remote access activity, as well as encryption and timing of the channel opening, shall be provided.
- j. Remote access to applications and/or services, performed by mobile endpoints through wireless (Wi-Fi and/or Cellular) network shall be performed from security-hardened endpoints only, against a dedicated network segment.

12.10.4 Network Security

Proactive network protection shall be implemented based on multiple components/technologies, as follows:

- A. Firewall – Firewall devices capable of traffic stateful inspection and certified for ISO 15408 shall be implemented. The Firewalls shall support traffic separation at interface level, through IEEE 802.1Q VLAN, for logical network partitioning, policy and management separation.
- B. An industrial Firewall that supports the required protocols and performs DPI (Deep Packet Inspection) shall be defined. The Firewall shall also support segmentation, which shall be defined in accordance with the risk assessment and topology analysis.
- C. An Intrusion Prevention System (IPS) and an Intrusion Detection System (IDS) (internally) shall be deployed both externally and internally to the firewall technology implemented, protecting the network environments. The proposed IPS/IDS systems shall support signature-based, anomaly-based and stateful protocol analysis.
- D. Network Application Firewall – Malicious code protection based on network application firewalling (e.g., content filtering technologies, application gateway firewalls) shall be implemented at the relevant interfaces as described in the following Reference Architecture and information flow Diagram.
- E. End-to-end communication security shall be implemented based on common practice secure protocols such as SSH, IPSec, SSL/TLS.
- F. Access control lists shall be implemented on all network and security devices.
- G. Network client authentication – Network client authentication shall be implemented using common standards such as IEEE 802.1x in the various network segments.
- H. NAC – NAC or equivalent system shall be implemented on every network in the CBN. NAC shall ensure that only the required and approved network connections are allowed. In addition, updated industry standard protocols, encryption mechanisms, mutual authentication and credential protection shall be used.
- I. VoIP Security – the proposed VoIP security solution shall follow industry best practices for VoIP security.
- J. VoIP Systems – the VoIP systems (including RoIP gateways and network extension units) shall have the voice and signalling data logically segregated from the data traffic. VoIP-ready Firewalls shall be employed to secure the proposed VoIP systems.

- K. Public Switched Telephone Network (PSTN) Security – PSTN security shall be based on implementation of dedicated IP PBXs for internal and external voice communications. Voice firewalls shall be employed to secure the proposed IP PBX systems. Telephony security shall also prevent external fraud by unauthorized parties by securing and monitoring the telephony system. Interfaces to external IP PBXs shall be via dedicated Firewalls and VoIP gateways.
- L. Virtualization security practices, if such technology is used, shall follow industry best practices. In addition, a security hardening of the virtualization environment shall be performed according to the virtualization software vendor recommendations.
- M. A virtualization technology solution shall be implemented per specific core networks only.
- N. Automatic Clock Synchronization – automatic clock synchronization for computers, networks, security and telecommunication systems shall be secured and shall work through a time Firewall or equivalent in order to mitigate any blocking, jamming, spoofing or any other malicious attack.
- O. Automatic clock synchronization shall comply with Time Based System. All security events shall be synchronized with the TBS. The TBS equipment shall comply with CMRL guidelines.
- P. Updates – the latest version of the operating system/firmware for all security devices shall be used.
- Q. A structured Testing environment for updates is required.

12.10.5 Firewalls

Firewalls shall comply with the following:

- A. Integrated threat intelligence adaptive threat protection against command and control (C&C)-related botnets and policy enforcement based on GeoIP.
- B. Carrier-class routing features of IPv4/IPv6, OSPF, BGP, and multicast.
- C. Firewall Services shall follow industry best practices
- D. Network Address Translation (NAT) shall follow industry best practices.
- E. VPN Capabilities shall follow industry best practices:
 - a. **Threat defense and intelligence services shall provide: Spotlight secure threat intelligence and protection from botnets (command and control); Adaptive enforcement based on GeoIP; Threat prevention to detect and block zero-day attacks; Routing and dynamic routing protocols; Multicast; Encapsulation; Virtual routers; Policy-based routing; Source-based routing; Equal-Cost MultiPath (ECMP); Firewall Quality of Service (QoS); Marking, policing, shaping, classification and scheduling; Guaranteed and maximum bandwidth control; Ingress traffic policing; Virtual channels.**
 - b. **Firewall devices switching & network services shall follow industry best practices.**

12.10.6 Data Security

- A. The information system shall protect the integrity and confidentiality of transmitted information at the application level. Mechanisms used to ensure data integrity shall be based on message authentication, hash-functions, and digital signatures.
- B. Industry-recognized cryptographic protocols shall be implemented for message integrity, where applicable, to detect information changes during transmission.
- C. Updated industry-standard cryptographic mechanisms on the applicable data shall be deployed to prevent unauthorized disclosure of information during transmission.
- D. Protection mechanisms detecting and eradicating malicious code (such as viruses, worms, Trojan horses) shall be implemented at information system entry and exit points.
- E. Relevant Protection mechanisms detecting and eradicating malicious code (such as viruses, worms, Trojan horses) shall be implemented at Workstations, servers, or mobile computing devices connected to the network.
- F. The SCN environment – where proactive protection mechanisms can impair system's real-time performance, minimal-impact protection techniques (such as applications and services whitelisting and signing, and monitored and recorded sessions) shall be implemented.
- G. A CMRL approved secure mediation measure (CDR) for controlled mediation and transfer of information from non-trusted sources, such as removable media, to the core networks shall be implemented. The mediation process shall follow industry best practices.

12.10.7 Security Administration

- A. Security policy and procedures
Written IT security policy and procedures shall be developed, issued and submitted to CMRL for approval.
- B. Classification and designation of sensitive information and assets
 - a. A classification and designation guide that contains procedures for classification, declassification, designation and downgrading of IT information and assets shall be developed. The classification and designation guide shall specifically address all types of information processed in the IT environment.
 - b. IT assets shall be classified and designated according to their importance, integrity, availability and value.
- C. Separation of duties
 - a. To the extent possible, it shall be ensured that responsibilities are separated in such a way that no individual has complete control over related critical IT & OT operations.
 - b. The following duties should be separated:
 - i. Operations
 - ii. System administration
 - iii. Network administration

- iv. Database administration
- v. Application programming/development
- vi. Testing
- vii. Security management
- viii. Production
- c. **For each of the core networks, management of IT assets** shall utilize a solid privilege separation security perception. IT assets shall be concentrated in dedicated, separate based on their function, for example IT resources, back-office, etc.
- d. Centralized management for servers and network devices shall be implemented separately in each of the autonomous networks, based on industry recognized NMS (e.g., HP Open View, Cisco Works) and centralized monitoring system that will collect the alerts from the entire NMS system through a diode, to build integrated visibility.
- e. Standard Authentication, Authorization and Accounting (AAA) methodology shall be implemented.
- f. Network security management – In SCN and OCN core network management shall not be permitted via the Internet, VPN or any third-party network.
- g. Cryptographic keys for required cryptography employed within the information system shall be established and managed. Industry best practices key management shall be followed, using full standard PKI.
- h. All security devices that contain sensitive cryptographic keys shall not be managed remotely.

12.10.8 Network Devices

- A. All network devices shall be configured and hardened according to known best practices and guidelines. The exact list of guideline and hardening procedures documents shall be defined and provided to CMRL for approval.
- B. It is required that the latest stable version of the operating system for all network devices is used.
- C. The proposed firmware shall support and follow updated protocols, best practices and industry standards.
- D. All routers/switches shall support and follow updated protocols, best practices and industry standards.

12.10.9 Server, Host and End-point Security

- A. Each server and workstation shall be configured and hardened according to known best practices and guidelines. The exact list of guideline and hardening procedures documents shall be defined and provided to CMRL for approval. The security capabilities of the operating systems shall be optimally leveraged and configured. Monitoring capabilities shall be implemented on each network, including the SCN, OCN, ACN, SCADA, TCMS and Rolling Stock On-board equipment as well.

- B. ISS shall incorporate EDR technology (Endpoint Detection and Response) and EPP capabilities, including host Firewall, device control configuration management, disk encryption and Host based IPS, to meet the need for continuous monitoring of and response to advanced threats.
- C. The Concessionaire shall add a capability to remove 'suspected as compromised' mobile devices from the network, manually and automatically (with an override option).
- D. Workstations used for processing and storing sensitive information (i.e. signalling information or any information that will be defined as critical by CMRL) shall be protected with additional control measures, such as containers, MDM or equivalent.
- E. Workstations used for processing and storing critical operational information shall have at least the following security measures implemented: TPM or SAM for secure key storage and operation; Machine BIOS setting shall be protected by password.
- F. Strong malware protection (against zero-day attacks), including: Personal Firewall; Host based IDS/IPS, anti-virus (Endpoint protection & Endpoint detection and response) package.
- G. A device control solution shall be implemented, including applying customized security policies over all physical, wireless and storage interfaces (e.g., USB, modem, Wi-Fi, Bluetooth, and external hard drives).
- H. Mobile computing device security
 - a. The Metro System's mobile computing devices that contain or have access to the operator information or IT applications shall be protected in accordance with Operator Information Security Policy and Standards. Mobile computing devices shall utilize Operator's approved encryption tools.
 - b. All mobile computing devices that contain or have access to Metro System Information or IT applications shall have:
 - i. Automatic log-off mechanism
 - ii. Process to prevent unauthorized viewing of user IDs or passwords
 - iii. Safeguards based on the information's classification.
 - c. The communication connections shall be defined as a private line for predefined use only. The line shall be used to connect the edge equipment (smartphone or tablet) to the system from point to point, without additional connections.
 - d. Edge devices (smart phone/tablet) shall be hardened and shall ensure the developed application supports the hardening.
 - e. The devices shall allow the usage of specific applications while blocking Internet surfing, connecting to other public networks, downloading applications and any other use that presents a potential Information Security risk.
 - f. The option of connecting to Bluetooth and public Wi-Fi networks shall be blocked.

- g. The communication channel shall be encrypted via high grade encryptions, such as AES 256.
- h. An AAA mechanism shall be defined for access purposes, user identification and authentication.
- i. It shall not be possible to insert devices such as disks-on-key into the edge equipment.
- j. Preventive CSOC and NOC monitoring operations shall be defined in order to identify attempts to penetrate the system by unauthorized and potentially hostile elements, including the injection of malware.
- k. The system shall have autonomous monitoring capability, with alerts sent to the CSOC system in the event that penetration into the system, viruses or malware are detected.

12.10.10 Application Security

A. Implemented Services and Applications shall follow industry best practices for secure development:

- a. Applications, databases and services shall not run with full operating system privileges and shall be granted the minimum required privileges. Databases shall not be granted admin privileges.
- b. Applications providing web interfaces shall comply with current OWASP secure web development guidelines.
- c. Applications shall never connect to a database using the database administrator account or an account with system or management privileges.
- d. Generally accepted principles for secure coding (SDLC) shall be implemented for all applications development.
- e. Mobile code – process for authorization, monitoring, and control of the use of mobile code within the information system shall be established.
- f. Applications shall utilize prepared SQL statements and/or stored procedures to minimize the risk of SQL injection.
- g. All access to the database services shall be implemented using a dedicated Data Access Layer Component (DALC).
- h. Applications shall support updated encryption protocols, with 256-bit minimum, for all communications interfaces.
- i. The application shall validate all provided inputs and shall not trust submitted or presented data.
- j. The application or a security solution above it shall have proper and secure session management to protect the sessions from unauthorized access, modification or hijacking.
- k. Standard cryptographic APIs shall be used for cryptographic processing, if applicable (i.e., Bsafe, OpenSSL).

B. Monitoring

- a. A process of monitoring the identification, authentication, authorization and access control, and administration of information infrastructure security shall be implemented to determine if proper security has been established and maintained. All security events shall be managed at a CSOC that shall be installed and operated at the OCC/TCC NOC.
- b. The monitoring platform shall include the possibility for a wide range of queries and analysis capabilities for threat hunting operations and incident investigation.
- c. The Information System shall be capable of generating audit information for at least the following security-related events:
 - i. Job or process status (entry, initiation, completion, deletion, restart, and abort)
 - ii. File, volume, and database accesses where applicable (open, close, create, delete, rename)
 - iii. Communications devices connect, disconnect and re-configuration
 - iv. Network status messages
 - v. User log-on and log-off attempts (including failed attempts and session timeouts)
 - vi. System operator commands and responses
 - vii. Any actions performed with administrative privileges
 - viii. System and subsystem status messages (start-up, shutdown, abort)
 - ix. System-generated messages or requests regarding configuration changes
 - x. Changes to system logging facility status (start, stop, alter, print, dump, delete, rename and overflow)
 - xi. Changes to access control information
 - xii. Changes to lists of authorized users
 - xiii. Detected security incidents
 - xiv. Use of privileged or powerful software
 - xv. Unauthorized network scanning such as port scans
- d. For each auditable event, at least the following information shall be generated:
 - i. Nature and type of incident
 - ii. Date and time
 - iii. User identification
 - iv. Device identification (IP/MAC address, host name)
 - v. Job or process identification
 - vi. Identification of resource accessed
 - vii. Mode of access

- viii. Configuration details
 - ix. Details of the performed activity/action (e.g., change password, update permissions)
- C. The system shall maintain the confidentiality of authentication credentials (e.g., passwords) by excluding or masking them in the audit log.
- D. Security event logs shall be generated and kept for each device and system and shall be sent to Security Information and Event Management (SIEM) for further analysis, correlation, and evaluation in order to identify and respond to suspicious activity. The event logs shall be kept for a minimal period of 1 (one) year. The proposed SIEM system shall support exporting the SIEM event logs to an external/detachable storage device.
- E. The protection of security log information from unauthorized access, modification, and deletion shall be ensured.
- F. A proper audit record storage capacity and configure auditing shall be allocated to reduce the likelihood of such capacity being exceeded.
- G. Audit records shall be retained for a minimal period of 1 (one) year, to provide support for after-the-fact investigations of security incidents and to meet regulatory and organizational information retention requirements.
- H. SIEM platform shall be implemented for centrally collecting, analyzing and correlating generated audit information. The correlation engine shall be capable of generating real time alerts (SMS, email) and reports for detected suspicious events and security violation.
- I. The Physical Security Information Management (PSIM) System and the Incident Management System (IMS) shall be capable of interfacing with the SIEM solution in the Metro System, using standard interfaces such as syslog or equivalent.
- J. SIEM collectors shall be installed in the operational networks. The unidirectional transmission of the SIEM data shall be secured.
- K. The Concessionaire shall establish a process of detecting and monitoring cyber threats on the signalling, systems and networks of the Chennai Metro Project to both the vehicles and the control equipment without disrupting the Chennai Metro Project's proper functioning, and without blocking their communications with the OCC. The Concessionaire shall provide a cyber security dashboard to provide operators with real-time intelligence, forensics and visibility on their Rolling Stock fleet condition and threats.
- L. The Concessionaire shall continuously assess vulnerabilities and weaknesses in the signalling architecture, manages the railway assets and configuration, and offers an effective response to threats in order to mitigate risks.

12.10.11 System Availability and Continuity

- A. Contingency plans shall be developed, documented and maintained to ensure the essential level of service shall be provided following any loss of processing capability or destruction of IT Systems. All systems shall have Disaster Recovery (DR) capabilities as required in the Transit Management Systems document and systems specifications.
- B. The system implementation of contingency plans shall not compromise data sensitivity or integrity requirements.

- C. Critical security controls shall be built for resilience and high availability.
- D. Backup – The backup shall maintain the same security policy (confidentiality, integrity and availability) on the backed-up data as on the operational environment. Backups of sensitive data shall have strong encryption and key management. The system shall include the capability to back up and restore all security-relevant data. Processes for secure handling of backup media shall be developed and implemented. Backups shall be kept in at least two separate locations (in addition to the OCC). One of the backup copies shall be kept as an offline backup.
- E. Each environment shall be individually backed-up.
- F. Metro System security shall comply with RAM requirements.

12.10.12 Technological Means for Security

- A. Security policies, physical means and security systems for preventing unauthorized physical access, damage and interference with the organization's information assets and equipment shall be implemented, before the installation of any active equipment of the following systems: ISS, Communication and IT Systems, P-SCADA, F-SCADA, signaling and CBTC and Security Systems-related equipment and systems.
- B. Refer to the Security Requirements of the Data Centers, as specified in the Transit Management Systems document .
- C. A physical security safeguards shall be implemented in the Metro System facilities. The computer data center shall have physical protections which prevent access by unauthorized personnel, , as specified in the Transit Management Systems document and the Security Systems .
- D. The appropriate restricted zones for areas shall be established where sensitive IT systems, assets, information and support utilities will be located. These areas include:
 - a. **Data Centers.**
 - b. **All the control centers - OCC, NOC, SOC, CSOC.**
 - c. **Offices and their related computer equipment.**
- E. Access and authorization to the Metro System's zones and premises shall be subject to security and authorization-based business needs and based on segregation of duties.

12.10.13 Equipment Security

- A. IT equipment shall be protected from theft. Where possible, such equipment shall be locked in racks or secured rooms. Secure table locks shall be implemented for laptops, desktops, monitors or other end user equipment.
- B. Network and Data Center cabinets shall be installed and cabling shall be secured. Communication rooms and rack cabinets shall be locked and equipped with alarm sensors. Manholes and hand holes shall be securely locked. Where they house active communication equipment, they shall be secured with alarm sensors.

12.11. Security Requirements per Network

The following section provides detailed security requirements applicable to the core networks that are part of the Metro System.

12.11.1 SCN - Signalling Communication Network

The security elements listed below shall be implemented in the SCN core network:

- A. Strong authentication – including authentication based on token or smartcard, certificates and biometric.
- B. The network layer, which shall be based based on common practice for SCADA and signalling systems (e.g. Purdue model), shall be segregated from the different services of the networks' i.e., it is important to ensure separation between SCADA elements and the VSS elements on the same network.
- C. Authentication of users and equipment shall be implemented through centralized and dedicated mechanism for the network directory service.
- D. User permission shall be based on RBAC mechanism.
- E. Dedicated IT infrastructure for mission critical process control systems shall be implemented.
- F. A dedicated Monitoring system and IDS for the signalling system shall be designed.
- G. A change management mechanism shall be implemented for device configuration monitoring.
- H. Segregation and physical isolation of critical (signalling process control systems) from other networks using a CMRL approved dedicated one-way traffic (data diode type) security device.
- I. The outgoing communications flow between the SCN and the OCN networks, required for proper system functionality, shall be implemented by means of physical one-way traffic enforcement (Diode Type) security device, along with application-level content filtering of the outgoing system messages (by means of data schema enforcement and fields' format and content rules compliance verification, as a minimum).
- J. The SCN shall not include any ingoing communications connections, except a dedicated, one-way connection for application status updates. This connection shall be implemented as a dedicated physical Firewall segment, using a physical one-way traffic enforcement (Diode Type) security device, along with application-level content filtering of the incoming system messages (by means of data schema enforcement and fields' format and content rules compliance verification as a minimum). The application messages format that shall be allowed on this connection is XML only, and any data field transferred through it shall be of a finite enumerated data type, without any usage of strings, binary data blocks and/or unstructured data. The amount of the application interfaces implemented through this connection shall be kept only for the mandatory communication, and each such interface shall be individually submitted to CMRL for approval, after thorough functional necessity analysis.
- K. Each connection in the system shall be based on a solid and valid business case or flow. The list of business cases shall be defined, analyzed and presented as part of the system functional design, for CMRL's approval.
- L. Signalling core network stateful Firewall shall be implemented for networks segmentation.

- M. In addition to all other recording requirements, all sessions to this network shall be recorded.
- N. Remote access to this network, if required, shall be subject to the approval and control of CMRL.
- O. Connection sessions' timeouts shall only be established when the operation does not require permanent connections.
- P. Device control shall be enforced – physical, wireless and removable devices shall be disabled. In addition, sleep mode (i.e., power management state) shall be disabled.
- Q. A direct and dedicated link for Maintenance access to network devices or endpoint equipment shall be implemented and performed through dedicated Workstations only.
- R. Unused network ports on devices and equipment shall be disabled.
- S. All unnecessary ports and services at embedded devices shall be disabled.
- T. All built-in system security features shall be enabled.
- U. Download and execution of mobile code (e.g., ActiveX, JavaScript, and VBScript) shall be blocked.
- V. Controlled mediation of information from non-trusted sources such as removable media shall be implemented.
- W. Hard drive locks shall be implemented.
- X. Tamper proof casing of applicable devices and equipment shall be implemented.
- Y. Industry recognized Firewalls for Industrial Control Systems (ICS) shall be implemented where applicable compliant with the ISA99 standard.

12.11.2 OCN – Operational Communication Network

The OCN core network shall have the following security elements implemented, including, but not limited to:

- A. Strong authentication – token based with pin or smartcard, biometric and machine-based certificates.
- B. Authentication of users and equipment shall be implemented through a centralized and network-dedicated Active Directory service.
- C. User permission shall be based on an RBAC mechanism.
- D. Dedicated IT, Networking and security infrastructure shall be implemented.
- E. Safety critical process control systems shall be logically segregated and isolated from other networks using dedicated security devices.
- F. OCN network traffic with ACN shall be controlled by security device. The traffic flows shall be permitted on a business needs basis only.
- G. OCN core network stateful Firewall shall be implemented for networks segmentation.
- H. Remote access (from interfaces external to the BTN) to this network shall be permitted only for compelling operational needs, shall be strictly controlled, and shall be approved in writing by CMRL. The number of users who can

obtain access from remote locations shall be limited and justification/approval for such access shall be controlled, documented, monitored and recorded.

- I. Connection sessions' timeouts shall be established only when the operation does not require permanent connections.
- J. Device control shall be enforced – physical, wireless, and removable storages shall be disabled. In addition, sleep mode (i.e., power management state) shall be disabled.
- K. Download and execution of unauthorized mobile code shall be blocked.
- L. Direct link for maintenance access to network devices or endpoint equipment shall be implemented and performed through dedicated Workstations only.
- M. Unused network ports on devices and equipment shall be disabled.
- N. All unnecessary ports and services in embedded devices shall be disabled.
- O. All built-in system security features shall be enabled.
- P. Hard drive locks shall be implemented.
- Q. Tamper proof casing of applicable devices and equipment shall be implemented.
- R. Industry recognized Firewalls for Industrial Control Systems (SCADA) shall be implemented where applicable.
- S. Controlled mediation of information from non-trusted sources such as removable media shall be implemented where applicable, compliant with the ISA99 standard.
- T. All unnecessary ports and services in embedded devices such as PLCs and RIU's shall be disabled.

12.11.3 ACN – Administrative Communication Network

The ACN core network shall have the following security elements implemented, including, but not limited to:

- A. Strong authentication – token based with pin or smartcard and biometric.
- B. Authentication of users and equipment shall be implemented through a centralized and network-dedicated AD service.
- C. User permissions shall be based on an RBAC mechanism.
- D. ACN network traffic shall be controlled by network Firewall, application Firewall, web proxy servers and anti-malware/anti-spam security devices. The traffic flows shall be permitted on a business needs basis only.
- E. An ACN core network stateful Firewall shall be implemented for networks segmentation.
- F. Direct link for Maintenance access to network devices or endpoint equipment shall be implemented and performed through authorized Workstations only.
- G. Unused network ports on devices and equipment shall be disabled.
- H. Device control shall be enforced – physical, wireless and removable storages shall be controlled. In addition, features such as auto-run feature (from any connectivity of external authorized devices), sleep mode (i.e., power management state) shall be disabled.

- I. Controlled mediation of information from non-trusted sources such as removable media shall be implemented.
- J. Hard drive locks shall be implemented.
- K. Remote access to the network and resources shall only be permitted providing that authorized users are authenticated, data is encrypted across the network, and privileges are restricted.
- L. Data exchange with external bodies shall take place through a secure platform for managing, sharing and protecting critical information.

12.11.4 F&EN (Fire and Emergency Network)

The F&EN core network shall have the following security elements implemented, including, but not limited to:

- A. Strong authentication – such as token based, with PIN or smartcard, biometric and machine-based certificates.
- B. Authentication of users and equipment shall be implemented through a centralized and network-dedicated Active Directory service.
- C. User permission shall be based on an RBAC mechanism.
- D. Dedicated IT, Networking and security infrastructure shall be implemented.
- E. Safety critical process control systems shall be logically segregated and isolated from other networks using dedicated security devices.
- F. If needed, F&EN network traffic with the OCN shall be controlled by a security device. The traffic flows shall be permitted on a business needs basis only.
- G. An F&EN core network stateful Firewall shall be implemented for networks segmentation.
- H. Remote access implementation in this network shall be permitted only for compelling operational needs, shall be strictly controlled, and shall be preapproved in writing by CMRL. The number of users who can obtain access from remote locations shall be limited, and justification/approval for such access shall be controlled, documented, monitored and recorded.
- I. Connection sessions' timeouts shall be established only when the operation does not require permanent connections.
- J. Device control shall be enforced – physical, wireless, and removable storage devices shall be disabled. In addition, sleep mode (i.e., power management state) shall be disabled.
- K. Download and execution of unauthorized mobile code shall be blocked.
- L. Direct link for maintenance access to network devices or endpoint equipment shall be implemented and performed through dedicated Workstations only.
- M. Unused network ports on devices and equipment shall be disabled.
- N. All unnecessary ports and services in embedded devices shall be disabled.
- O. All built-in system security features shall be enabled.
- P. Hard drive locks shall be implemented.
- Q. Tamper proof casing of applicable devices and equipment shall be implemented.

- R. Industry recognized Firewalls for Industrial Control Systems (SCADA) shall be implemented where applicable.
- S. Controlled mediation of information from non-trusted sources such as removable media shall be implemented where applicable, in compliance with the ISA99 standard.
- T. All unnecessary ports and services in embedded devices such as PLCs and RIU's shall be disabled.

12.11.5 Traffic Light Communication Network (TLCN)

The TLCN core network shall have the following security elements implemented, including, but not limited to:

- A. Strong authentication – such as token based with PIN or smartcard, biometric and machine-based certificates.
- B. Authentication of users and equipment shall be implemented through a centralized and network-dedicated Active Directory service.
- C. User permission shall be based on an RBAC mechanism.
- D. Dedicated IT, Networking and security infrastructure shall be implemented.
- E. Safety critical process control systems shall be logically segregated and isolated from other networks using dedicated security devices.
- F. TLCN network traffic with the OCN shall be controlled by a security device. The traffic flows shall be permitted on a business needs basis only.
- G. A TLCN core network stateful Firewall shall be implemented for networks segmentation.
- H. Remote access implementation in this network shall be permitted only for compelling operational needs, shall be strictly controlled, and shall be preapproved in writing by CMRL. The number of users who can obtain access from remote locations shall be limited and justification/approval for such access shall be controlled, documented, monitored and recorded.
- I. Connection sessions' timeouts shall be established only when the operation does not require permanent connections.
- J. Device control shall be enforced – physical, wireless, and removable storages shall be disabled. In addition, sleep mode (i.e., power management state) shall be disabled.
- K. Download and execution of unauthorized mobile code shall be blocked.
- L. Direct link for maintenance access to network devices or endpoint equipment shall be implemented and performed through dedicated Workstations only.
- M. Unused network ports on devices and equipment shall be disabled.
- N. All unnecessary ports and services in embedded devices shall be disabled.
- O. All built-in system security features shall be enabled.
- P. Hard drive locks shall be implemented.
- Q. Tamper proof casing of applicable devices and equipment shall be implemented.
- R. Industry recognized Firewalls for Industrial Control Systems (SCADA) shall be implemented where applicable.

- S. Controlled mediation of information from non-trusted sources such as removable media shall be implemented where applicable, in compliance with the ISA99 standard.
- T. All unnecessary ports and services in embedded devices such as PLCs and RIU's shall be disabled.

12.12. Security Systems Specific Requirements

12.12.1 General

- A. As derived from Information Security aspects and operational systems requirements, several separate physical networks shall be implemented as indicated below:
 - a. **Signalling Communication Network (SCN).**
 - b. **Operational Communication Network (OCN).**
 - c. **Administrative Communication Network (ACN).**
- B. The following are specific guidelines for interfacing systems. Security means shall be provided to ensure a secure and accurate system, in full collaboration with other systems suppliers (e.g. external interfaces, GIS, etc.).

12.12.2 RSS (Railway Scheduling System)

- A. The RSS resides in the ACN network, which is physically separated from the OCN and SCN networks.
- B. Sharing information between the different networks shall be based on business needs.
- C. Connections between the SCN and any other network (including any required connections between RSS and SCN) shall be implemented according to the requirements described in this document.
- D. The integration between systems shall be permitted only after conducting a risk assessment process followed by a risk management mitigation plan.

12.12.3 Rolling Stock On-board Systems

- A. As some of the Rolling Stock systems shall be connected to other systems which are not onboard the Rolling Stock, a connection between these systems shall be established. The two relevant separate networks are the SCN and OCN. The connection between these networks shall be protected in order to prevent unauthorized access to the networks.
- B. The commercial network, which is used for Internet access for passengers, shall be completely isolated from the operational and signalling systems. The network separation shall be performed end-to-end, starting with the On-board communication equipment, through the Wideband Wireless Radio System (WWRs/WCDS), to prevent unauthorized access to system resources.
- C. The rolling stock systems which are related to the OCN network shall be separated from the rolling stock systems which are related to the SCN network (in terms of hardware, software and infrastructure). The separation between the networks should be based on a Firewall that will establish an encrypted tunnel which will be connected to a DMZ on the OCC side, and from the DMZ, will be securely connected to the relevant network.

- D. Specific requirements for On-board signalling are provided in the On-board specification document and the WWRS/WCDS, RMCS, as specified in the Communication Systems.
- E. WWRS/WCDS shall provide backup to the RMCS and therefore all ISS restrictions shall apply.

12.12.4 ATS and SCADA Interface

- A. The ATS is physically separated from the Power SCADA.
- B. One-way information flow (outgoing) shall be permitted to the ATS only by enforcing a unidirectional link (data diode) dedicated security device, approved by CMRL.
- C. Content filter shall be implemented at OCN, based on security gateway/network application firewalling (e.g., content filtering technologies, application gateway firewalls). All information shall be checked for malicious code.
- D. The integration shall be permitted only after conducting a Risk Analysis process and mitigating the risks.

12.12.5 Interface between Cellular network and Metro CBN (APN/VPN)

- A. In order to allow secured connectivity between mobile devices such as smartphones and tablets to Metro IT systems, a dedicated interface from Cellular (4G/4.5G/5G) public network to the CBN shall be established.
- B. A solution for interfacing the CBN via a 4G/4.5G/5G VPN (provided by one of the authorized carriers in India) shall be provided.
- C. The Chennai Metro Project shall operate an internal cellular core. The project's terminal/mobile devices shall not be able to receive service from commercial cellular providers, and shall be disconnected from the open Internet.
- D. The following are the security requirements regarding this interface:
 - a. The Metro System authorized and predefined mobile devices shall use an isolated and dedicated APN in the Cellular network.
 - b. The connection between the Cellular service providers network will be terminated in a dedicated separated physical interface in the OCN FW.
 - c. An independent dedicated encrypted tunnel shall be established between the Cellular service provider's data network and the OCN. Users connected to the private APN shall be redirected to the encrypted tunnel
 - d. A private line for predefined use only: The line shall be used to connect the edge equipment (smartphone or tablet) to the PSIM system from point to point, without additional connections.
 - e. Mobile edge devices (smartphone/tablet etc.) shall be hardened, and shall ensure the developed application supports the hardening.

12.13. Security Requirements for Testbed and Pre-Production (Staging) Environment

12.13.1 Staging

- A. A physically segregated Pre-production (Staging) environment shall be implemented.
- B. The Pre-production environment shall be used for testing IT and OT equipment before its assimilation into the production environment.
- C. The Pre-production environment shall mirror an actual production environment as closely as possible. It shall connect to other production services and data, such as databases.
- D. The primary use of a pre-production environment is to test all the installation/configuration/migration scripts and procedures before they are applied to a production environment. This ensures that all major and minor upgrades to a production environment are completed reliable and free of errors, in a short as possible amount of time.
- E. The staging environment shall be used for performance testing, particularly load testing.

12.13.2 Testbed and Model

- A. The Concessionaire shall design, install and maintain a systems model of a Hardware, Software and infrastructure-based test environment. Which is coherent with the overall and most updated architecture of the Chennai Metro DC, communication and IT environment.
- B. The entire environment shall be thoroughly examined in several steps on different types of testers prior to its installation and activation in the field.
- C. The test environment shall be a downscaled test platform model of all actual systems and infrastructure for on-board, depot, at-grade, stops and signalling.
- D. The overall examination and assessment of the testbed and model environment, shall constitute the cyber security tests, before its functional activation. .
- E. The objectives of this test environment are to:
 - a. Approve the goal of protecting data availability, integrity and confidentiality of Chennai Metro Project computing and Information Systems and the resilience of the CBN, systems & subsystems to cyber security attacks.
 - b. Confirm compliance with cyber security requirements as detailed in this document, complying with CMRL requirements.
 - c. Test and approve new, updated components before adding them to the production environment.
 - d. Learning the pattern of actions and forensics capabilities of cyber security events.
- F. Test environment components shall include all systems and subsystems as detailed in the functional subsystems mapping (Appendix, section 12.11).
- G. Testbed complexes:
 - a. Test complex.
 - b. Scenarios complex.
 - c. Scenarios management complex.
 - d. Testbed management complex.

- e. Debriefing complex.
- H. The testbed model and its components shall be transferred to CMRL after completion of the tests.
- I. The location of the testbed shall be coordinated with and approved by CMRL.
- J. CMRL shall be entitled to carry out testing specifically aimed to detect vulnerabilities in the signaling and CBTC system and/or its components, including all system software components, in its own cyber labs. Alternatively, it may contract an external testing body for this purpose.

12.14. Cyber risk Assessment and Penetration Testing

12.14.1 Periodic Cyber Risk Assessment

- A. The Concessionaire shall conduct an Initial cyber risk assessment prior to the design phase.
- B. The Concessionaire shall periodically (every 24 months as a minimum) conduct a cyber risk assessment in order to assess the capability of an external or an internal hacker to compromise the project systems, network and applications.
- C. The cyber risk assessments shall address multiple points of attacks, including External and internal.
- D. Every cyber risk assessment shall include a detailed report that will include an executive summary, a methodology section, a finding section and a relevant mitigation plan section.
- E. The cyber risk assessment reports shall be submitted to CMRL no later than 30 days after the assessment's execution date.

12.14.2 Penetration Testing (PT)

- A. The Concessionaire shall periodically conduct a PT (multiple testing) in order to assess the capability of an external or an internal hacker to compromise the project systems, network and applications. The PT shall comply with the following requirements:
 - a. PT for critical components of the Chennai Metro – every 12 months.
 - b. PT for non-critical components – every 18 months.
- B. In addition, the Concessionaire shall conduct PT prior to PTO, during the trial running of the Metro system.
- C. The PT shall be conducted in coordination with the cyber risk assessment, as specified in section 14.1 above.
- D. Before conducting the PT, the Concessionaire shall present CMRL with the PT scope of work and objective.
- E. The PT shall simulate multiple points of attacks, including External and internal modi operandi.
- F. The PT shall include a detailed report that will include an executive summary, a methodology section, a finding section and a relevant mitigation plan section.
- G. The PT reports shall be submitted to CMRL no later than 30 days after the PT execution date.

1.2.16 Active Harmonic Filter System (AHF)

1.2.16.1 Scope of Work

Design, assembly / fabrication, installation, testing and commissioning of 3 phase, 4 wire 415 V, 50 Hz Active harmonic filter System (AHF) which defined as a power electronic device consisting of power semiconductors known as front end insulated gate bipolar transistors (IGBT) that switch into the AC lines to modulate its output to mitigate detrimental harmonic current; correct the displaced reactive current (leading or lagging); and balance the current (also known as negative sequence current) for the power source.

1.2.16.2 Standards

AHF System shall comply with the following standards:

- IEEE 519 – 2014: Guide for Harmonic Control and Reactive Compensation of Static Power Converters.
- AHF: The Active harmonic filter shall be of certified design confirming to IEC 60529, CE EMC Certification IEC/EN 61439-1, EN 61000-6-4 Class A, EN 61000-6-2.
- IEC 60529- Degree of Protection Provided by Enclosures (IP Code)
- ASCE 7- Minimum Design Loads for Buildings and Other Structures.
- ACB/MCCB: IS :13947 (Part 2),IEC 60947-1,2 & 3
- ASTM E 329- Standard Specification for Agencies Engaged in the Testing and / or Inspection of Materials Used in Construction
- UL 508- Standard for Industrial Control Equipment
- UL 1449- Standard for Transient Voltage Surge Suppressors

1.2.16.3 Performance Requirements:

3-ph/4-wire, 415 V,Active harmonic filter should be Modular and Scalable. AHF shall implement the following.

- Step-less dynamic Power Factor Correction (for both leading and lagging current).
- It Should have feature of Harmonics Compensation up to 51st order(All the orders)
- It should have the feature of Load Current Balancing in the three phases and Neutral Correction.
- PCBA protection : PCB's used shall have G3 conformal coating and relevant test report certification as per ISA-71.04 shall be submitted.
- THD(v) shall be limited to not more than 5 percent as contributed by the loads at the location of each AHF. THD(v) set point may be set to optimize performance of the AHF and maintain less than THD(v) set point.

- THD(i) shall be limited to 3% or less as long as AHF is 50% or more loaded and all nonlinear loads have 3% or larger input impedance. A THD(i) set point may be set to optimize THD(i) performance.
- Displacement power factor shall never go leading due to AHF Performance or design.
- Displacement Power factor shall be corrected to 0.95 or better at the location of each AHF.
- AHF shall provide field selection as harmonic filter, reactive current correction, or supply current balancing or any combination of the three modes. All modes shall be required for this project. First priority will be given for Reactive power compensation to achieve optimized unity PF, Leading (capacitive) or lagging (inductive) power factor to target.
- Should have 3 level topology by 12-IGBTs.
- Should have integrated overload, overvoltage & under voltage protection etc.
- AHF Should ensure low losses.
- AHF Should be of modular Design and should be scalable with different Ampere ratings.

1.2.16.5 Principle of Operation

AHF should measure level of harmonics in supply line and eliminate it by generating the counter harmonics. It should employ a advanced DSP which determines the harmonic current amplitude to be injected in the opposite phase angle of each harmonic order. Along with harmonic compensation, it should be able to take care of power factor (lead and lag) and unbalance correction at the point of connection.

The AHF Panel shall not only provide harmonic mitigation, but also, power factor correction and load balancing. Harmonic correction, PF correction and Unbalance correction should be able to set with priority.

- The active harmonic filter shall mitigate harmonics from the 2nd harmonic up to the 51st harmonic and limit the Total Harmonic Distortion. Voltage shall be within the limits as specified in IEEE Std 519-2014 (Standards on IEEE recommended practices and requirements for Harmonic Control in Electric Power System). The active filter shall be connected in parallel (shunt) to the load.
- The active filter shall be suitable for connection to a distorted voltage source and its operation shall not be adversely affected by pre-existing voltage distortion.
- The active filter shall be suitable for operation on an electrical system having a generator as its power source.
- AHF should have high attenuation greater than 97% of individual harmonics
- AHF shall be able to mitigate 2nd to 51st harmonics order discrete, fully selectable per harmonic order (amplitude and on/off).
- AHF shall include an option to achieve optimized unity PF, Leading (capacitive) or lagging (inductive) power factor ($\cos \phi$) to target.

- Mains current balancing shall be achieved by measuring the negative sequence current present and injecting the inverse negative sequence current to balance the current for the upstream network.
- When station is lightly loaded, the system should sense that there is no reactive demand in the station the power factor at the metering point will fall due to leading reactive power demand of the transmission line. The system should utilize its capacity in drawing lagging reactive power from grid to cancel out the leading reactive power of the transmission line to ensure good power factor at the metering point.

1.2.16.6 Essential Requirements for The Point Of Reliability

- All the filter design shall adapt modular construction and shall be scalable with any Ampere range of filters.
- Cooling Architecture : Segregated Cooling (Separate for heat sink and separate for PCB's)
- AHF should also have safety feature of Grid resonance protection.

1.2.16.7 Electrical Ratings:

- System Voltage: 415V AC \pm 10%, 3ph 4 Wire/3 wire
- Line voltage tolerance: \pm 10%
- System Frequency: 50 Hz
- Frequency tolerance: 50 Hz \pm 3% autosensing
- Harmonic Cancellation Current: Multiple filter units of different ratings for parallel connection may be used to achieve total current requirements for combined power factor correction and harmonic mitigation.
- There should be possibility of connecting any rating of multiple units in parallel.
- Current transformers shall be with Class 0.2S or better with 15VA rating.
- Flexibility to select CT ratio shall be also be available.
- Surge withstand capability per ANSI/IEEE STD C62.41-1991.
- The Active harmonic filter shall be of certified design confirming to IEC 60146-1.
- EMC Certification IEC/EN 61439-1, As per International Standard: UL508
- AHF should have automatic roll back feature.
- AHF should have THDi & THDv target set points.
- AHF should have optimized PF setting.

1.2.16.8 Basic Product Requirements

The active harmonic filter shall meet the following basic requirements:

- Active filters shall include input surge suppression.
- Active filters shall include forced air-cooling system.
- Active filter shall be able to connect in both open loop and closed loop configuration

- Active filter should have a HMI touch screen display having the functionality of a power analyzer and should display parameters as mentioned below
- Current Parameters: Arms, A1rms, iTHD (%), Aunb
- Voltage Parameters: Vrms, V1rms, Urms, vTHD (%), Vunb, Frequency
- Power Parameters: Active, Reactive, Apparent Power
- Power Factor
- Displacement Power Factor
- Filter Parameters: Apk, Filter Utilization, Stack Temperature, DC Voltage, Filter Runtime, Fan Runtime, Panel Temperature
- Voltage and current waveforms
- Voltage and current Harmonic spectrum
- Alarm indications & log details
- Shall have an operating temperature range of 0 °C to 45 °C.
- Maximum Altitude: 3300 feet (1000 m) with derating at 1% per 100 meters.
- Humidity: to 95 percent, non-condensing.
- AHF shall provide reactive power compensation for both leading & lagging Current.
- Balance the load in all phases & unload the neutral wire.
- AHF Shall have 3 level topology to ensure low losses & higher quality voltage output (Ripple should be very low).
- AHF should have following inbuilt safety features:
 - Overload protection.
 - Internal short-circuit protection.
 - Overheating protection.
 - Overvoltage & undervoltage protection.
 - Inverter bridge protection.
 - Resonance protection.
 - Fan fault protection.
- Active filter shall be isolated from the power supply when powered “off”.
- Front End technology IGBT modules shall be self-protected for maximum reliability.
- The panel control response time shall be less than 100µs and the correction time shall be less than 5ms.

1.2.16.9 Construction:

- Constructed on metal panel with minimum IP 42.
- Filter shall be suitable for operation upto an ambient temperature 45°C with suitable ventilation and shall give an alarm signal in case of temperature going beyond a set limit.

- Shall be able to work with higher temperature with automatic de-rating (80% capacity at 50oC) and absolute shutdown when temperature reaches 51 Degrees.
- Storage temperature shall be from 0oC to 70oC with suitable packing
- Active filters shall be suitable for operation in relative humidity up to 95% non-condensing.
- Panel shall have an audible noise level less than 75db as per ISO3746
- Panel shall have a filtering efficiency of at least 97%
- Panel shall have a Control response time shall be less than 100µs.
- Power factor correction shall always be set at priority.
- Priority selection between the remainder features - harmonics compensation and load balancing - shall be programmable at the time of commissioning. In the default mode, harmonics compensation is set at 2nd priority and load balancing is set at 3rd priority
- Auto fold-back of the AHF panel if total current requirement exceeds the rated capacity of the panel
- All live parts of the system shall be properly shrouded
- Inspection terminal strip, number ferruling, and other labelling shall be suitably provided
- Stickers marked with "DANGER" shall be provided wherever required
- Detailed drawings and manuals shall be provided wherever required
- Following protections shall be provided:
 - Over voltage (AC) protection
 - Over voltage (DC) protection
 - Phase sequence protection
 - Over current protection
 - Over temperature protection
 - Protection circuits for the inverter stack and its components
- The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with powder coating in the approved colour shade/s to match the colour of the other panels. The thickness of powder coating should be minimum 60-80 microns, 2 mm thick CRCA sheet steel.
- Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided if required.
- The enclosure system shall be from the same OEM. The AHF Panel shall be manufactured by OEM's only and factory acceptance test (FAT) shall be carried out at OEM's plant.

1.2.16.10 Switchgear & Protection

Incomer switchgear shall be TP&N breaker appropriate rating.

Bus bars shall be Copper Bus bar suitably colour coded and must be mounted on appropriate insulator supports.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures up to 125°C.

Internal wiring between main busbars, breaker, contactor and capacitors shall be made with 1100 V grade, PVC insulated, FRLSH copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc.

Suitable bus links for input supply cable termination shall be provided.

1.2.16.11 Control Circuit & General Protection

The control circuit shall be duly protected by using suitable rating MCB.

An emergency stop push button shall be provided to trip the entire system (mushroom type, press to stop and turn to reset).

Wiring of the control circuit shall be done by using 1.5 sq.mm, 1100 V grade, PVC insulated, multi-stranded copper control wire.

Inspection terminal strip, number ferruling, labelling etc. shall be provided.

440 V caution board on the panel shall be provided.

1.2.16.12 Operator Interface:

- a) AHF shall have a door-mounted human machine interface (HMI) with touch screen control rated NEMA 4-12 (IP65), dust-tight and liquid-resistant.

Note: HMI is not suitable for outdoor use.

- b) HMI shall provide run / stop control from every screen. HMI shall provide an oscilloscope feature to display specific parameters.
- i. Three sets of data may be monitored at a time. Up to twenty predefined parameters can be chosen for each curve.
 - ii. Performance trend curves shall be displayed for load total RMS current, load RMA harmonic current per phase, AHF harmonic current output per phase, AC mains voltage per phase, THDi, TDD, load RMS reactive current, and AHF RMS reactive current output.
 - iii. Bar graphs shall be provided for display of the mains and load harmonic current amplitudes per harmonic order.
 - iv. Selected internal curves shall be provided for diagnostic and performance checks
- c) HMI shall display operating and setup parameters and event fault messages in plain English, no cryptic codes or symbols are permitted on the display. HMI shall display the mains voltage and CT current. Parameter adjustment shall be made via HMI and shall be password protected. HMI shall record and display an event log with time and date. Event log shall be cleared via the stop function or power-off. A minimum of 100 events shall be stored.

- d) HMI shall provide external communications via an RJ45 connectors. Modbus TCP / IP shall provide remote run / stop and display of operating parameters, set-up parameters and diagnostic functions. HMI shall have a safety feature that shall lock out all other forms of control during service and commissioning. After 15 minutes of non-use the lockout shall clear and control functions shall revert to full functionality and remote-control capability. HMI shall display a flashing warning screen in the event of a fault. HMI shall download pertinent parameters to a USB memory device to permit remote diagnostic evaluations and to save unit set up parameters.
- e) HMI shall include, but shall not be limited to, an on-board commissioning guide with automatic detection features. AHF shall automatically check for proper AC line phase rotation. No specific phase rotation is required. AHF shall automatically test for CT phase rotation and polarity. If installation is incorrect, AHF shall be able to rotate and reorient CT's through its own logic calculation. If proper alignment cannot be achieved, a fault warning and lockout of operation shall occur. AHF shall automatically calibrate the CT for optimum harmonic cancellation performance. AHF shall perform at full capacity for a period of 15 minutes to validate components meet temperature performance requirements in the installed location. In the event any of the above cannot be reconciled, HMI shall lock out AHF function until commissioning agent corrects, verifies, and clears each test.

1.2.16.13 Installation

- AHF Panel shall be installed as per installation manual of OEM and shall conform to relevant International / Indian Standards.
- All interconnections in the control panel shall be checked before commissioning.
- Cable end boxes shall be sealed after cable connections to prevent absorption of moisture.

1.2.16.14 Testing and commissioning-

- Insulation resistance shall be tested with a 1000 volts megger between phases and phase to earth.
- The active harmonic filter Manufacturer shall carry out the following tests based on a mutually agreed sampling plan for demonstrating the performance of the Active Harmonic Filter cum load balancer and dynamic VAR compensator:

1.2.16.15 Harmonic filtering test

The AHF is connected to mains and in parallel with a programmable harmonic generator. The Programmable Harmonic Generator is set to generate a series of harmonic spectrum comprising of single as well as multiple harmonics. The spectral composition, magnitude as well as phase angle of individual harmonics are varied.

Target THD is set on the AHF and the harmonic filtering efficiency is measured for typical harmonic signature spectrums.

1.2.16.16 Submission and approval of drawings-

Following drawings and technical documents shall be submitted along with the drawing approval copy.

- Technical data sheet GA drawings.
- Bill of Material.
- General Technical Particulars.
- All type test of components as per there relevant Standards.
- Type Test for AHF.
- Design Validation to be done based on final loads at the time of Project Execution
- Heat Dissipation Calculation.

1.2.16.17 Inspection & Tests

All tests and inspection shall be made at the place of the manufacturer unless otherwise especially agreed upon by the manufacturer and the purchaser at the time of purchase. The manufacturer shall afford the inspector representing the purchaser, all reasonable facilities, without charge, to satisfy him that the material being supplied is in accordance with the specification.

The complete PQ Solution assembly shall be subject to routine tests including functional test of the control, protection and interlocking schemes. The routine tests shall be carried out at its place of manufacture.

Routine test results should be a part of the O&M Manual and shall be produced at the time of delivery of the equipment.

The manufacturer shall prepare a programme for routine tests and submit these to the client / consultant at least on month before commencement of the programme.

Acceptance test for Reactive power correction (leading, lagging) and Harmonics mitigation shall be demonstrate at Factory.

1.2.16.18 Routine tests:

All tests shall be carried out in the presence of and to the satisfaction of the purchaser or his and at such times as he may reasonably require.

All instrument used for testing purposes, shall if required by the engineer be calibrated by an approved authority.

The cost of all tests shall be included in the contract price and shall not be quoted for separately.

1.12 UNINTERRUPTIBLE POWER SUPPLY

1.12.1 General

This section specifies the manufacture and installation of Uninterruptible Power Supply System, hereafter referred to as UPS. The UPS systems shall maintain continuous AC Power supply to the loads classified as the Signal & Telecommunication and **Emergency** category loads for the station.

1.12.2 Standards

Relevant Codes and Standards

The UPS and their constituent parts shall comply with the relevant latest version of British Standards (BS), European Standard (EN), International Electrotechnical Commission (IEC) standards, International Organization for Standardization (ISO), Research Designs and Standards Organization (RDSO), Indian Railways Specification (IRS) Standards as specified below.

The following standards (or latest) shall apply where appropriate:

S. No.	Code/Standards	Description
1	IEC 62040 – 1 & 2	Uninterruptible power systems (UPS) - Part 1: Safety requirements, Part 2: Electromagnetic compatibility (EMC) requirements
2	IEC 62040 - 3	Method of specifying the performance and test requirements
3	BS EN 50091	General and safety requirements for UPS used in operator access areas
4	BS EN 62368-1:2014+A11:2017	Audio/video, information and communication technology equipment. Safety requirements
5	BS3535; EN 60742	Specification for safety isolating transformers for industrial and domestic purposes
6	IEC 60529	Degree of Protection provided by Enclosures
8	BS EN IEC 62040-2 EN 61000-4-3	Electromagnetic compatibility (EMC) Testing and measurement techniques. Radiated, radiofrequency, electromagnetic field immunity test
9	BS EN IEC 62040-2 IEC 61000-3-2 61000-3-3, EN 61000-3-2 61000-3-3; VDE 0875	Electromagnetic compatibility (EMC) Limits - Limits for harmonic current emissions (equipment input current ≤16 A per phase) Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection

10	IEC 61000-4, EN 61000-4; BS EN IEC 62040-2; BS EN 50121	Electromagnetic compatibility Testing and Measurement Techniques
11	IEC 60982	Level measuring systems utilizing ionizing radiation with continuous or switching output
12	ISO 3746, BS 4196-6	Sound Power Levels of Noise Sources Part 6: Survey Method for Determination of Sound Power Levels of Noise Sources
13	IEC 61439 – 1	Low-voltage Switchgear and Control gear Assemblies- General Rules
14	IEC60947 – 4-1 EN 60947-4-1	Low-voltage switchgear and control gear - Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters
15	BS 7671	Requirements for Electrical Installations. IET Wiring Regulations-18 th Edition
16	BS 7430 / IS 3043	Code of practice for protective Earthing of Electrical installations
17	IEC 62133	Safety requirements for portable sealed secondary lithium cells, and batteries made from them, for use in portable applications - Part 2: Lithium systems
18	IEC 62620:2014	Secondary cells and batteries containing alkaline or other non-acid electrolytes -Safety requirements for portable sealed secondary lithium cells, and for batteries made from them, for use in portable applications - Part 2: Lithium systems
19	IEC 61960-3:2017	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for portable applications - Part 3: Prismatic and cylindrical lithium secondary cells and batteries made from them
20	IEC 62281:2016	Safety of primary and secondary lithium cells and batteries during transport
21	IEC 61508	Functional Safety Electrical/Electronic/Programmable Electronic Safety Related Systems: Applicable for all Battery Energy Storage Systems
22	UL 1973	Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications
23	IEC 61643-1	Surge Protective Devices
24	RFI Suppression	BS EN IEC 62040-2, EN 55022A or VDE 0878

25	Flammability Tests	IEC 60707 / Equivalent International Standards.
26	Rectifier	RDSO Spec IRS: S91-93
27	MIL-STD-7041A / Equivalent International standards	Transient Protection
28	ISO 9001, ISO 14001, ISO 45001	Quality Management, Environmental Management & Occupational Health & Safety Management

1.12.3 Technical and Installation Requirements of Three Phase UPS

1.12.3.1 General Requirements

Electromagnetic Compatibility

All equipment shall comply with EN 50091 – 2 & IEC/EN 62040 – 1 ,2 & 3 and the following standards for the requirements of electromagnetic compatibility

- Electromagnetic Compatibility - Immunity:IEC 61000-4-3
- Electromagnetic Compatibility – Emission:IEC 61000-3-2/ 61000-3-3VDE 0875.

The radio frequency interference (RFI) levels generated by the UPS equipment shall also be in accordance with the requirements of BS EN 55014-1 or latest, IEC 61000-4-3.

Noise Level

Noise emanating from the UPS during operation shall not exceed 65 – 70 dBA at a distance of 1m from the enclosure, over a load range of 10% to 100% of the rated full load, as per the standards ISO 3746.

Environmental Conditions

The Contractor shall ensure in design that the UPS shall be capable of withstanding any combination of the possible environmental conditions without mechanical or electrical damage or degradation of operating characteristics

UPS system shall normally operate under the following Conditions.

- Operating ambient temperature: 0 to 45 °C
- Relative humidity: Up to 95 %
- Storage temperature: 0°C to 55 °C
- Operating Altitude: Sea Level to 1000 Meters

The equipment shall be designed to provide rated output at 40 °C

The equipment shall be RoHS compliant.

Irrespective of above said conditions, the UPS shall operate satisfactorily in Chennai Metro Corridor climate and environmental conditions.

1.12.3.2 Reliability

The minimum MTBF (for failures resulting in load power interruption) for each UPS system complete with automatic supply changeover switch and static bypass switch shall be at least 80000 hours.

1.12.3.3 Design Life

The design life of the UPS and Battery system shall be at least 15 years.

1.12.3.4 Emissions in case of fire

The equipment shall not generate any toxic emissions in case of fire. The emissions shall be governed by the latest relevant international specifications.

1.12.3.5 General System Features:

The general system features are mentioned here, which are detailed in the subsequent clauses.

The UPS shall be a true parallel redundant, Double Conversion (VFI technology as per SS111 and Voltage, Frequency Independent in accordance with IEC62040-3) Online type with 3-phase, 4 – wire 415 V input and 3 – phase, 4 – wire, 415 V (Phase to neutral, 230 V) output complete with replaceable power stacks like converter, inverter, Bypass Static switches. UPS system comprising of rectifier, Inverter, inbuilt automatic Bypass and Manual Bypass to be offered to cater the load in each UPS. Battery backup having charging arrangement and other standard accessories. It should be a 3- Level inverter technology or better.

The UPS shall conform to IEC 62040 – 3 and the specifications given below. In case of any conflict between the two, the most stringent conditions will apply.

Each unit (UPS) shall be modular in construction to facilitate unit replacement and all electronic control cards and power modules shall permit plug in type replacement. The enclosure shall be separate for each UPS and dust & vermin proof provided with IP-20-degree Ingress protection to IEC 60529, designed for space requirements to facilitate maintenance and installation.

Each UPS unit should have an independent power & control circuits which included all switchgear, electronics cards, Static Power Components for Rectifier, Inverter and Static Switch.

All materials and components of the UPS shall be new, of current manufacture, and shall not have been in prior service except as required during factory testing. The UPS shall be constructed of replaceable subassemblies. All active electronic devices shall be solid-state. All the Switches (input / Output / Bypass) are located in-built and UPS doors are of lockable type.

Both the UPS unit shall provide controls, metering & monitoring system and self-fault diagnostic / annunciation system for healthy/faulty status through LEDs or LCD, data logger with power monitoring software for operational status locally.

UPS shall be compatible to take 100% non-linear loads and capable to handle high crest load. UPS shall be provided with harmonics filter as well as input power factor correction features. UPS shall be compatible to work on 2 sources of supply with acceptance of reverse phase sequence protection. In case of phase reversal at the

input, system should be capable of supplying energy to load from the batteries without any break. At the same time it should also generate audio and visual alarm in such case.

In the event of Main power failure or rectifier failure in one UPS the other redundant UPS shall take care of full load connected in output panel without moving to Battery mode. At the same time it should generate audio and visual alarm in outside of room/SCR and the same to be communicated to BMS/SCADA. When Power resumes automatically both UPS shall share the loads by equal.

The system shall be standard tried out product of an established manufacturer and shall comprise of minimum number of components with maximum MTBF & MTTR. The system shall have high operating efficiency, front access and self-diagnostic features. There shall be sufficient redundancy in all vital parts to achieve a breakdown -free operation of the system.

The System shall essentially consist of following major components.

1. Converter and inverter assembly.
2. Built-in battery breaker enclosure in battery rack and built-in static & maintenance bypass in UPS shall be provided.
3. DSP processor-based Menu driven software for operation, control and management as well as microprocessor - controlled diagnostics. Ventilation for the system shall be provided with adequate redundancy to maintain component temperature within the required limits. All air entries shall be protected with cleanable filters. All heat producing devices shall be mounted on ample heat sinks.
4. UPS shall be mounted as a whole on a heavy-duty fabricated steel base frame constructed from folded channel sections with suitable mounting pads
5. UPS shall be designed for Lithium Batteries which shall be as per UL 1973

1.12.3.6 System Description.

The UPS system shall consist of the following components but not limited to:

- IGBT with PWM technology Rectifier/Charger
- IGBT with PWM technology Inverter,
- Lithium Battery System,
- Battery Circuit Breaker,
- Static Bypass Switch,
- Manual Bypass Switch, and
- Control Units and Interconnections between different UPS Elements.
- Isolation Transformer with suitable configuration operate to metro rail type location.

Each UPS system shall be supplied from two independent LV essential busbars at 415 V, 3 - phase and 50 Hz via MCCB's as shown on the single Line Diagram. For static/maintenance bypass supply shall be provided by a single source for both UPS. Necessary breakers to be considered and get prior approval from Engineer.

The rectifier / charger and inverter shall be of an On - Line (Double Conversion, VFI Technology) UPS configuration. In case of failure of the selected mains supply source, the battery system shall immediately discharge to maintain the UPS load Output without interruption.

The UPS output voltage shall always be in synchronization with the mains supply voltage feeding the static by-pass switch.

Static by-pass switch shall perform automatic make-before-break switching of the UPS load to either the inverter supply or the mains supply source. The static bypass switch shall be directly connected to one of the mains supply sources. The UPS shall withstand the switching transient or fault energy produced when the make-before- break operation of the static bypass switch parallels two different supply sources.

A manually operated make – before - break manual by-pass switch shall be provided for manually switching the loads to the mains supply source and for isolating the loads from the UPS system.

The UPS system shall be equipped with an interlocking system to prevent parallel operation of any non-synchronized sources activated either by any manual switches or automatic switches.

The UPS output shall be of 415 V, 3 phase, 4 wire via Moulded Case Circuit breakers, as specified (in the above Section), enough to supply the full rated output load. The UPS shall be capable of supplying 100% non-linear types of loads.

In case of failure of one UPS or in the case of one UPS to be taken out of service for maintenance purposes, the remaining UPS shall cater to the battery backup of the common battery bank automatically without any breakup to the connected loads at rated capacity. The UPS shall be provided with an interface for remote monitoring of status and alarms, as specified.

The UPS systems shall incorporate sufficient batteries to provide power supply backup of rated full load for not less than the specified duration as per BOQ.

Surge protective devices shall be provided at the inputs and output of the UPS to protect the UPS and the load equipment against any power surge due to lightning, switching, etc.

Modes of Operation

The UPS shall operate in each of the following modes:

Normal Mode (Mains Up)

- During normal operation, the mains shall feed the load via the UPS (an ON-LINE system). The rectifier / charger section shall convert the mains power to direct current, which is used simultaneously to float charge the battery system and supply DC power to the Inverter. The inverter shall invert the direct current into alternating current within the specified parameters.
- Under normal conditions, the UPS output voltage waveform shall be sinusoidal and be synchronized with the mains voltage feeding the static by-pass switch,

keeping the output frequency, voltage magnitude, phase sequence and phase displacement synchronized with that of the mains supply. During breaks, the UPS output frequency shall be controlled by an internal precision oscillator without switching to batteries.

Stored Energy Mode (Mains Down)

In the event of a momentary or prolonged loss of mains supply, the UPS battery system shall supply sufficient power to maintain the specified UPS output for not less than the support time specified.

Battery Recharge (Mains Restored)

- When mains supply is restored from failure or restored via automatic supply changeover switch, the rectifier / charger shall resume the supply of DC power to the Inverter and batteries. During this period, no interruption or disturbance shall be caused to the inverter output.
- When the battery system is fully charged, the rectifier / charger shall automatically adjust the output voltage to float charge the battery system.

Automatic By-pass Mode (Static By-pass Switch)

- In the event of overloads exceeding system capabilities (short-circuits, heavy inrush current or battery capacity being exhausted upon rectifier / charger supply down) or the detection of internal faults, the static by-pass switch shall instantaneously synchronize with the inverter output and transfer the loads to the bypass supply source without load interruption.
- Retransfer of the load to the UPS shall be accomplished, after the restoration and stabilization of the output power modules to the specified tolerances, without disturbance to the load.

In both these transfers, UPS output voltage and frequency tolerances must remain within the specified limits.

Built in Manual By-pass (Maintenance)

The built-in manual bypass switch shall be manually operated to perform make-before-break switching of the UPS load to either the UPS or the Mains supply source without load interruption, for UPS maintenance purposes. On UPS load being connected to by-pass supply, full access to the UPS input / output equipment shall be possible.

Maintenance of Batteries

For maintenance purposes, it shall be possible to isolate the battery system from the rectifier / charger and the Inverter by means of a circuit breaker. In such a case, the UPS shall continue to supply the load as specified herein, except in the event of mains supply outage.

Mains Supply

Input Voltage: 415 volts AC (-15 % to + 15%)

Wiring: 3-phase, 4 wire and earth Input Frequency: 50 Hz \pm 5%

Input Power Factor

The total power factor of UPS as a load shall be from 0.99 lagging to unity, with rated load, fully charged battery, and input voltage within +15% to - 15% of the nominal value.

System Efficiency

In normal Mode the efficiency of the proposed UPS shall be above 90% from 25% load to full load with the fully charged batteries (including isolation transformer) and 70% minimum for rated load while recharging the battery.

Harmonics on Input Voltage

Relative harmonic content on the input voltage shall not exceed 5% of the RMS value of the rated input voltage and harmonic components shall not exceed values given in IEC 62040-3.

Reflected Input Harmonics

The rms value of all harmonics in the input current waveform contributed by the rectifier shall not exceed 5 % of the rms value of the fundamental frequency with the UPS operating at rated voltage and current.

Load Unbalance Capacity

The UPS shall have the capability to accept up to 50% load unbalance with the ratio of current in the most loaded phase to the current in the least loaded phase not exceeding 1.5, provided that the most loaded phase current does not exceed the rated line current.

Overload Capabilities

The UPS shall be able to supply 110% for 60 minutes, 125% rated load for at least 10 minutes and 150% rated load for at least 1 minute.

Output Voltage

- Rated voltage: 415 volts, 3-phase, 4-wire.
- Steady state voltage regulation: $\pm 1\%$ for a load between 0 and 100% of full rated value, irrespective of value of the normal mains supply voltage and DC voltage, provided these voltages are within the limits specified.
- Transient voltage regulation: Output voltage transients shall not exceed the limits of classification 1 specified in IEC 62040-3 Clause 5.3.1 and ENV 50091-3/ 62040-3 Clause 3.2.1 during change in operating mode, 100% step change in load or fault clearing.
- Output voltage adjustment: $\pm 5\%$ of nominal voltage.
- Steady state voltage unbalance (difference between phase voltage and the arithmetic average of the three-phase voltage): $\pm 1\%$ maximum for balance load, $\pm 3\%$ maximum for 50% unbalance load.
- Phase displacement: $120^\circ \pm 1^\circ$ for balanced load; $120^\circ \pm 3^\circ$ for 50% unbalanced

load.

- The output voltage shall not dip more than 20% in case of any fault on the load side of UPS.
- Total Harmonic Voltage Distortion Content of each UPS: Less than 1% with linear load, less than 5% with non-linear load (Crest Factor of 3:1)

Output Frequency

- Rated frequency: 50 Hz.
- In normal operation, the output frequency of the inverter shall be synchronized to that of the bypass supply source within the limits of 3% (settable)
- For frequency variations exceeding these limits, the inverter shall switch over to free-running mode, with regulation, providing an output frequency to within $\pm 0.1\%$ of the rated value without switching to batteries.
- Frequency slew rate: 2 Hz / second maximum.

Load Current Crest Factor

A crest factor up to 3:1 for the load current shall be anticipated.

Reliability

Reliability shall be greater than 99.99%.

Current Limiting

The system shall be provided with inrush current limiting to 125% of the UPS rated load current.

Isolation Transformer

Isolation Transformer shall be provided with suitable configuration for metro rail operation, H class insulation shall be provided for Isolation Transformer & winding shall be made up of Copper and K factor shall be K-13.

Circuit Protection

Main circuit breakers shall be provided at both input and output within or external to the UPS, which fully discriminate with upstream and downstream circuit breakers. The system shall be provided with component protection, to minimize damage and downtime in the event of component failure, against:

- AC Supply voltage transients and transfers.
- Internal faults.
- Sustained overload.
- Load switching transients.
- Current surges.

The system shall be provided with interlocks to prevent accidental damage to the UPS during maintenance or normal operation. UPS system shall be designed with protection & annunciation system for monitoring the following:

- Phase sequence.
- Overload and short circuit trip.
- Earth fault protection
- Power Back feed protection
- Low battery voltage.
- Fault indication alarm through suitably designed hooter.
- Self-diagnostic annunciation system.

1.12.3.7 Rectifier/Charger

The input of the rectifier / charger shall be protected by an built-in / external circuit breaker with adjustable settings. A walk-in circuit shall be provided at the rectifier / charger input to eliminate sudden inrush current from the mains supply or changeover of supply source. The current walk-in shall take place in approximately **1 to 60** seconds to allow a gradual increase in the loading in the mains supply source.

The UPS shall have IGBT rectifiers to remove harmonics. The converter should be solid state PWM converter with IGBT rectifiers. The converter should have the following important features.

- Power Conversion
- Battery Charging
- Power Factor Improvement
- Current Harmonic Reduction
- Voltage Regulation
- Transient Recovery
- Automatic Synchronization
- Over-current Protection
- Over Temperature Protection
- Control Power Failure Protection
- Short Circuit Protection
- Current limiting function of battery charging to prevent the battery from being damaged.

The converter should meet with the following specification in addition to other requirements stated herein:

Nominal Voltage	415V, 3 Phase, 4 wire
Voltage range	+15% / -15% AC
Nominal Frequency	50Hz \pm 5%
Input Power Factor	0.99 lagging or more at full load Input
Harmonic Current THD	Less than 5%
Duty	Continuous

Cooling

Magnetizes sub cycle Inrush current

Forced Cooling

Typically 8 times normal full load

Converter Walk in Timer 1 through 60 Seconds (every 1 second selectable, to 100% rated load), Default setting 20 seconds Input Suitable terminals shall be provided for termination of cables from the AC Distribution Board

The rectifier / battery charger shall provide a regulated DC output for the inverter and the battery. The rectifier/charger regulation shall ensure that the DC output voltage fluctuations are less than 1% of rated value irrespective of load and mains supply voltage variations.

The rectifier / charger shall be equipped with a filter limiting the DC ripple voltage to a ripple free content

The rectifier / charger shall have sufficient capacity to enable simultaneous supplying of full load to the inverter and recharging a fully discharged battery to 100% rated value within 3 hours for Lithium Battery.

A protective circuit shall be provided to prevent battery overcharge. After the rectifier / charger has recharged the battery to 100% capacity, the rectifier / charger shall float charge the battery.

Provision shall be made to prevent the battery from over-charging due to battery charger rectifier fault. An adjustable battery current limiting device shall limit the battery recharge current to the maximum value recommended by the battery manufacturer. The rectifier/charger shall be electronically current limited to protect the connections to the Inverter input and to prevent damage to the battery.

The battery low-volt cut-off shall be set to suit the battery manufacturer's recommendation to ensure the battery is not damaged by a deep discharge.

The rectifier/charger unit shall be equipped with an over-voltage protection device.

1.12.3.8 Inverter

The inverter utilises IGBT with PWM technology and Digital Signal Processing to convert the DC power from the rectifier or converter to regulated AC power for output to critical loads with the performance requirements. The inverter should be a 3 Level inverter or better.

The inverter shall utilize the latest and reliable technology to achieve high efficiency and reliability, and to cope with non-linear loads. The inverter should incorporate following essential features:

- Voltage Regulation
- Transient Recovery
- Automatic Synchronization
- Over-current Protection

- Over Temperature Protection
- Short Circuit Power Protection
- High Speed switching (6 kHz)
- Frequency Control
- Inverter Output voltage Harmonic distortion
- Inverter Overload protection through electronic means

1.12.3.8.3 The inverter should meet the following specifications in addition to other requirements stated herein.

Voltage Input	Nominal 480V DC, Range - As per manufacturer recommendation
Nominal Voltage Output	415 / 240V, 3 Phase 4 wire / single phase respectively
Inverter Capacity	As per Specifications

Voltage Regulation

A) For 0 to 100% Loading	< ± 1%
B) Inverter DC Input Voltage	< ± 1%
C) Environmental Conditions Given Below	< ± 1%

Transient Voltage Regulation

A) At 100% Step Load Change	< ± 3%
B) At loss or return of AC Input	< ± 3%
C) At load transfer from Bypass to inverter	< ± 3%

Time to recover from transient to normal Voltage 20 milliseconds

Waveform

Normal frequency	50 Hz
Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination (automatically controlled)	
Synchronization limits for synchronism between the inverter and standby AC source < ± 3% 48.5 to 51.5 Hz	
Field adjustment range for above	50 ± 0.25 Hz to 50 ± 1.5 Hz
Phase Voltage Displacement	120.0 ° ± 1 °
Duty	Continuous Duty
Total Harmonic Distortion	< 2% THD for 100% linear load < 5%for 100% nonlinear load
Cooling	Forced cooling using fans

The inverter shall be capable to supply its rated load at unity power factor at 40°

Voltage harmonic distortion: The inverter shall provide sine wave output having harmonic neutralization and filtering to limit the total harmonic distortion on the output voltage to less than 1% of linear load and 5% of non-linear load.

Each inverter leg shall be protected from over-current to prevent damage to the solid- state devices in the inverter bridges.

The inverter output shall be electronically current limited.

The inverter shall be protected against over voltage and under voltage surges introduced at the output of the uninterruptible supply system by load switching and transfer to the bypass. If the bypass AC line deviates by more than 50 Hz \pm 2% the inverter logic shall automatically revert to 50 Hz \pm 0.25% and initiate an alarm condition.

1.12.3.9 Automatic Static Bypass Switch

General

- a) The UPS shall be provided with a static By-pass switch. In the case of inverter failure, sub-circuit failure, load start-up inrush or battery capacity being exhausted upon rectifier / charger supply down, the static bypass switch shall transfer the load to the mains automatically within 4 milli-seconds. Full protection discrimination shall be achieved on the bypass circuit. In case of a single sub-circuit fault, the capacity of the static by-pass switch shall withstand the fault energy until the protective device of the sub-circuit clear the fault.
- b) Built-in Back feed protection shall be provided for safety protection.
- c) The means of operation shall ensure a make-before-break uninterrupted transfer of load to or from the by-pass supply source under both automatic and manual mode of operation.

The static switch should also conform to the following minimum requirements

Continuous Capacity	Equal to the 100% continuous rating of the inverter
Overload Capacity	Equivalent to the overload characteristics of the UPS
Nominal Bypass input voltage	415V, 3-phase
Voltage Range	\pm 10% nominal
Nominal Frequency	50 Hz
Frequency Range	\pm 3%
Current	1000%- 20ms
Duty	Continuous

Cooling

Forced/Natural Convection

Capacity

The static bypass switch shall be able to carry the maximum system load. The current switching capacity of the switch shall be at least 1.25 times the UPS rated load current.

Transfer Conditions

- a) The static bypass switch shall transfer from the inverter to the by-pass supply source under the following conditions:
- Inverter under voltage (less than 90 % of nominal),
 - Inverter over voltage (greater than 110 % of nominal),
 - Inverter overload,
 - Inverter shut down for any reason (including failure), and
 - Manual signal.
 - DC circuit under voltage or over voltage.
 - Final end voltage of the system battery is reached.

At the same time, the inverter output shall be isolated to prevent the bypass supply source from back feeding power to the inverter.

- b) The static bypass switch shall inhibit transfer to the bypass supply source for the following conditions:
- Bypass supply source under voltage (less than 90% of nominal),
 - Bypass supply source over voltage (greater than 110% of nominal)

Transfer Sensing Time

The maximum transfer sensing time for loss of Inverter voltage shall be 4 milli-seconds.

Retransfer to Inverter

The static by-pass switch shall be capable of automatically retransferring the load back to the Inverter after the Inverter has returned to normal voltage and stabilized for a period of time or the overload due to short-circuit or high inrush current has disappeared. The system shall only retransfer the load to the inverter provided all the following conditions are met:

- The inverter and the bypass supply source are synchronized.
- Inverter voltage is within $\pm 5\%$ of nominal for 2 to 30 seconds (adjustable).
- Manual transfer signal off.
- The overload current disappears within 1 to 10 minutes (adjustable).

1.12.3.10 Internal Manual By-Pass Switch

A manually operated mechanical manual bypass 3 pole switch shall be provided for

The transfer scheme shall be make-before-break uninterrupted transfer of the load from the static bypass switch output to the external manual bypass supply source or vice versa.

The switching arrangement shall be designed to electrically isolate the UPS from the distribution board.

The current switching capacity of the manual bypass switch shall be at least Two times the UPS rated output current.

Key interlock between external manual bypass switch and the inverter switch shall be provided such that the inverter shall safely shutdown by transferring load to static bypass incase the external manual bypass switch is operated directly. In addition, the manual bypass switch shall be pad lockable.

1.12.3.11 **Battery System**

Lithium Ion Nickel Manganese Cobalt oxide (NMC) or combination of Lithium Manganese oxide (LMO) and Lithium Nickel Manganese Cobalt oxide (NMC) shall be used for Battery system and Storage battery banks shall be provided for the UPS with sufficient ampere-hour capacity to maintain the UPS output at the rated output capacity for not less than One Hour (60Mins) duration on the backup time for Each UPS unit. If combined battery bank shall have 2Hours(120Mins) back up time for rated output capacity.

The overall capacity of the battery system shall be such as to meet the specified performance and technical requirements throughout the life of the battery. The battery capacity shall be designed for long life with uniform charging and discharging rates. In calculating the battery capacity, backup time at Start of Life shall remain for 3 years, shall be taken into account. The lithium ion batteries shall be designed for minimum 15 Years lifetime in the following operating conditions: 2 cycles per year with DoD (Depth of discharge) 80%, 24 cycles per year with DoD 5%. If batteries are operated more than those conditions, it should have remaining capacity of 70-80% of BoL (Beginning of Life). This output power factor shall be 0.99. Battery sizing calculations shall assume an ambient temperature of up to 40°C. OEM / contractor shall submit the relevant battery sizing calculation report with proven software / design calculations for approval. The calculations shall include the above criteria and derating factors of battery / cell with respect to temperature, DOD, lifetime of equipment etc. The battery cell shall be of heavy duty, rechargeable, lithium ion battery and maintenance- free type and the performance shall comply with UL 1642 Safety having an intended design life of at least 15 years. Warranty of 10 Years must be offered on lithium-ion cells and the entire Battery system. If any defect/fault/non- working item during that warranty period, the supplier shall replace the battery/component immediately without any extra cost to the Employer. The warranty of 10 years for the replaced item will be calculated from the day of replacing date. Record of installed item and replaced item will be registered by manufacturer and tracking of record/equipment will be monitored by Engineer (O&M manual shall cover all the procedures to be followed with respect to UPS & Battery system and it shall be given by manufacturer after commissioning of system.

The battery bank shall be protected from internal fault by a circuit breaker. The UPS

shall be automatically disconnected from the battery bank when the discharge limits of volts per cell are reached, or when signalled by other control functions. Each Lithium ion battery cabinet shall feature a DC rated circuit breaker. The circuit breaker within the lithium battery cabinet shall only provide protection to the battery string within that battery cabinet.

Each UPS System is to be connected to a common battery bank of adequate AH capacity. In case of failure of one UPS or in the case of one UPS to be taken out of service for maintenance purposes, the second UPS shall cater to the loads automatically without any breakup to the connected loads at rated capacity.

The battery cabinet shall support top/bottom entry.

Battery monitoring shall be provided at the module, rack, and system level. Two switched-mode UL listed power supply (SMPS) shall be included and shall provide power for the battery monitoring system. The power to the SMPS shall be supplied by AC utility and UPS output

The lithium ion battery Monitoring system shall communicate with the UPS via dry contacts / other communication protocol.

During the Warranty period and after warranty expires, Defective Batteries must be shipped back to UPS supplier for disposal by Lithium Ion Battery vendor.

Built-In Battery Management Features:

The Built-In Battery Management should be designed in Lithium Ion Battery Rack with the goal to avoid the deterioration of battery age. The Battery Management – Key Features protect the battery from environmental negative impacts (high temperature and false manipulations) and preserve battery life by advanced management of battery charging and preventive failure diagnostics. Battery monitoring shall be provided at the module, rack, and system level all the time. The function of Battery Management system is to increase prolong the battery life, License free software to be inbuilt with the system and periodic update needs to be done automatically.

Three different Battery Monitoring System (BMS) –

- Module BMS
- Rack BMS
- System BMS

Module BMS: Cell Voltage and Temperature Measurement, Communication to Rack BMS

Rack BMS: Rack Voltage and Current Measure, SOC and SOH Calculation, Protection Control, Events logging and alarms

System BMS: Consolidation at system level and user Communication

- AC-Ripple free battery charging due to DC-DC charger separated from the rectifier and inverter
- UPS'S wide input voltage window tolerance extends the battery life due to

- less discharge cycles
- Battery discharge protection caused by load jumps
- Proactive battery protection from false manipulations and inadequate charging voltages
- Proactive battery failure detection Algorithm
- User selectable battery tests
- The battery management system shall be remotely monitored through RS485 or Ethernet communication to Station SCADA
- Cell balancing feature

The battery rack shall be supplied with:

- The rack cabinet should be made up of SPCC (cold rolled steel sheet) steel for shelving the battery modules, switchgear and SMPS assembly. It shall be designed to provide easy access to all components for maintenance and to minimize floor space requirements.
- The rack cabinet should match the color of the UPS cabinet.
- Each battery cabinet shall require only front access for installation, service and maintenance.
- The sheet metal elements in the structure shall be protected against corrosion by a suitable treatment, such as zinc electroplating, bi-chromating, epoxy paint, or an equivalent. Paint thickness should be 80 microns.
- Switchgear assembly consists of protection devices and a rack BMS.
- BMS system should provide data to the external system (i.e building management, UPS etc.) while controlling and monitoring all connected rack BMS's. It should be provided with RS485, TCP/IP and Dry Contact.
- Inter-module connectivity shall be done by Tinned copper bus bars. During replacement particular string shall be in off condition for replacement and remaining system shall function at all time without load interruption or shut down.
- Temperature monitoring at each cell level to be implemented and shall have communication to rack BMS.

Temperature monitoring equipment shall be incorporated in the UPS system to optimize the charger voltage as a function of battery room temperature, to generate alarm in case of room temperature exceeding the preset permissible temperature and to predict the battery backup time.

The rectifier/charger shall follow recommendation of battery manufacturer for battery recharge. It shall also be equipped with facilities to carry out in-situ tests for battery (full and partial) discharge.

The cells shall be housed in aluminum containers of approved material of ample strength with flame retardant self-extinguishing characteristics to UL 94 rating FV0 and of sufficient depth to prevent possible short circuit of the plates by the deposition of any sediments. The cells enclosed in the modules shall be connected by laser

welding. It shall be equipped with a fuse, safety functional layer, Multi-layered separator, safety vent and Overcharging Safety Device to prevent any kind of short circuit

The battery shall have sufficient capacity and discharge characteristic to meet the requirement listed. The battery shall be suitable for the following charging duties: A fully discharged battery shall be charged to 100 % of its rated capacity within 3 hours under boost charge conditions.

The cell shall be of prismatic type made up of an organic solvent-based electrolyte. The cells are to be connected in series inside in the module. The battery rack enclosure should be of SPCC steel material.

The standard battery operating temperature shall be as per above with no de-rating of Battery life and cycles.

The batteries of each UPS shall be housed in at least two racks such that those in one rack can be disconnected for maintenance while the rest provide a full service for a shorter time.

The battery stand shall be constructed to give maximum support to the cells. The stand shall be equipped with a means of leveling.

Technical requirements of battery module

The offered battery shall have the following characteristics as a minimum suitable for cycle and floating application

- High performance & reliable
- High chargeability up to 100% capacity within 3 hrs
- Highly compact
- High charge efficiency greater than 95%
- Long life greater than 10years
- Low Total cost of Ownership
- High Discharge Rate up to 4C

Type of discharge duty cycle for battery set shall be selected based on the load cycle, duration and end cell voltage and end battery module voltage. Depth of discharge shall be 80%. Battery cells shall be designed to withstand the mechanical stresses encountered during normal transportation and handling.

Individual Module should have Cells connected in series in 1P configuration only. Series connection inside battery module shall not be connected directly through BMS PCB to avoid fire/flame during short circuit.

Vendor to submit the following information while offering the battery

- Technology
- Cathode material
- Anode material

- Electrolyte
- Type of cell construction
- Maximum voltage of cell, module
- Nominal voltage of cell, module
- Minimum voltage of cell, module
- Capacity of cell, module
- Cell configuration/arrangement in module
- Cell, module impedance / resistance
- Continuous discharge, charge current, preferred charging rate
- Cell, module protection details
- Cycle life data
- Ah, whr efficiencies
- Recharge profiles at different SOC levels
- Cell, module weight
- Size
- Energy density
- Cell internal pressure
- Cell, module heat during charge, discharge at full load
- Module terminal maximum current capacity

Technical requirements of Battery Management System

The supplier shall be providing a reliable BMS to monitor the healthiness of battery set and provide an efficient backup power to system to ensure continuity of service

The BMS shall be capable to sense and cut off the mains supply from battery during following situations

- Over charge
- Over discharge
- Over temperature

The BMS shall have provision to cut off the mains supply from battery through suitable device when module SOC reaches to 100% to avoid over charging. However, the module shall be ready for discharge even after cut off mains supply from battery.

The BMS shall be capable to equalize the cells during un-equalization. The BMS shall have current limit circuit to avoid over charging.

The BMS shall be capable to communicate thro-any industrial standard

communication protocol.

In addition to the external electronic controls that provide the normal means to prevent safety events, each cell shall be equipped with following safety devices

- Pressure release valves may be incorporated with the current-interrupting devices or may be separate components. These valves allow release of excessive internal pressure (cell venting) in abusive situations
- Shut-down effect separators to provide protection against over temperature rise

Technical requirements of Control Box

The main function of control box in each battery rack is to perform charge/discharge protection, short circuit protection, Healthy status of cells, current measurement and battery management via BMU.

The system should consist of Cell Monitoring Unit (CMU) and Battery monitoring Unit (BMU) for measurement, control and operation of Li-Ion batteries.

The rack design must be modular so that to increase the capacity the rack can be paralleled together. Function of CMU:

- Cell monitor and protection (Over charge, Over discharge, Cell temperature protection).
- Communication between BMU-CMU.
- Cell Voltage Measurement
- Cell Temperature Measurement
- Cell Balancing

Function of BMU:

- State of charge (SOC) calculation
- Battery Pack voltage determination
- Charge/Discharge current measurement (Over current protection)
- Communication between BMU-CMU
- Communication between BMU-System level BMS
- Bus Voltage Measurement: The BMU should measure the voltages of DC Bus and whole rack to judge if OV /UV event occur.
- Rack Current Measurement: The BMU should measure the current via a current sensor to judge if OC /OD event occur.
- SOC Calculation: The BMU must calculate the SOC via current count and look-up OCV table, to provide the host controller as a reference to do 10%~90% operation controls.
- Thermal Management.

For Rack Safety design, system must be equipped with:

- **Cell Fault Detection:** The BMU will communicate with CMU to get all the data of modules; while CMU send a warning/protection message, the BMU will cut the relay to protect cells work in hazard.
- **System Fault Detection:** The BMU built in self-diagnosis function and watchdog to avoid the controller fail without warning.
- **High Voltage DC Connection:** The High voltage DC bus should be insulated and should not be accessible to user.

1.12.3.12 Battery Circuit Breaker

Batteries shall be mounted on racks to allow access to all terminals. In reaching the terminals, maintenance staff shall not be required to stretch unduly over other batteries, with the risk of shorting battery terminals. A localized built in battery circuit breaker shall be provided for each battery bank.

1.12.3.13 Control and Indication Panels

General

The UPS shall be fitted with an integral control and indication panel. If the panel is not part of the cubicle, its construction and appearance shall match that of the main cubicle.

The panel shall be a touch screen display which includes:

- A mimic diagram, which shows the system components in blocks with symbols of circuit breakers, switches.
- The necessary instrumentation.
- Alarms and indications showing the operation of the UPS. Green and red LED shall be used to indicate the normal and alarm conditions respectively.

Controls

The following controls shall be included on, or inside of, the UPS module cabinet

- Start/stop control
- Rectifier/Charger
 - External Input circuit breaker,
 - DC float voltage adjustment,
 - DC boost (equalize) voltage adjustment,
 - Boost (equalize) voltage timer adjustment,
 - Boost (equalize) voltage time initiate switch, and
 - Boost (equalize) voltage timer reset.
- Inverter
 - AC output voltage adjustment,
 - AC output frequency limit
- Static By-pass Switch
 - By-pass input circuit breaker,
 - Transfer point voltage tolerance, range of frequency and phase error adjustments,
 - Retransfer timer adjustments (timers for inverter voltage and load current monitoring), and
 - Manual transfer switch.
- Alarms
 - Lamp test/reset push buttons,
 - Alarm test/reset push buttons, and

- Alarm silence push button.
- Emergency shutdown push button with protective cover. Provision has been provided to have external EPO

Instrumentation

The UPS shall be provided with, digital instrumentation to indicate, as a minimum, the following information. All readings shall have an accuracy of at least $\pm 0.5\%$ of true value. The settling time shall be less than 1 second to within one digit of final reading. If certain meter is used to display more than one parameter, a manual selector switch shall be provided for reading selection.

True RMS voltage

- UPS input voltage with phase selection,
- Rectifier output voltage,
- DC battery voltage, and
- UPS output voltage with phase selection.

True RMS current (crest factor – 3:1)

- UPS input current with phase selection,
- DC battery charge/discharge currents,
- UPS output current with phase selection, and
- By-pass source current with phase selection.

Frequency

- Mains frequency, and
- UPS output frequency.

Power (kW)

- UPS output power with phase selection.

Power Factor

- Inverter output power factor
- Elapsed operating time.

Indications and alarms

The UPS shall include a mimic diagram with LED indication or on LCD for the UPS equipment status and audible and visual alarm alerting annunciation. The status indication and alarm annunciation with the associated protection and control circuits shall include, but not be limited to, the following status and alarms. Required provision for remote monitoring shall be provided using suitable auxiliary contact/direct serial communication with Modbus serial (RS 485) or preferably TCP/IP for following signals: -

Equipment Status Alarms

UPS Input Voltage UPS Output Voltage

Dual Supply, Healthy Status

Rectifier/Charger

- Rectifier Normal
- Rectifier Failure
- Boost / Float Charge

Battery

- Battery Charging / Discharging
- Circuit Breaker Open
- Battery Test Run
- Battery Discharging
- Battery Low Voltage
- Battery Test Fail
- DC Over voltage

Inverter

- Inverter Normal
- Inverter Failure
- Inverter Overloaded
- Output over voltage / under voltage.

Static By-pass

- By-pass Normal
- Load on Inverter / Bypass
- By-pass Failure
- Synchronous Failure
- Static switch on manual

Manual Bypass

- Load on UPS / Bypass
- Manual Bypass Off / On
- Transfer Inhibited

Ventilation

- Fan Normal
- Over temperature alarm / shutdown (two stages)
- Fan Failure,
- Over temperature alarm (adjustable)

- Over temperature shutdown (adjustable)

Emergency Pushbutton

- UPS On
- Emergency Shut Down

Common Alarm

- Alarm triggered - Common Alarm
- Audible and visual annunciation shall be activated at the indication panel when an alarm has occurred. Such annunciation shall be latched on alarm occurrence and shall be such that it can only be cleared by pressing a manual reset button.
- The alarm state indications on LCD shall remain until a manual reset switch is operated and the alarm state has been cleared.

1.12.3.14 Diagnostics

The UPS shall be fitted with a DSP Processor based Supervision and Diagnostic System, which monitors all aspects of the UPS operation. The system shall aid in the rapid identification of internal faults.

The UPS shall automatically analyze the condition of the battery string on a programmable period. It shall detect and enunciate the battery failure condition locally and remotely. The periodic test shall not impair the battery readiness in case of normal supply outage.

One portable terminal complete with all the necessary software and hardware shall be provided at the Station for the monitoring and diagnostics of the UPS via preferably the TCP/IP or RS 232 / RS 485 data interface.

Mounting and Enclosure

UPS shall be free standing, floor mounted and have a minimum degree of protection of IP 20 in accordance with IEC 60529 and conforming to the international standards of ISO 9001. The control panels and switchgear cubicles shall generally comply with IEC 61439 – 1 / EN 61439 - 1 for standards of construction, safety and technical characteristics / tests.

All parts used in mounting and enclosure shall be of standard manufactured models.

Cabinet shall be constructed with material of thickness 1.6 mm for Non load bearing members and 2mm for load bearing members and suitably braced to form a rigid structure. Full substantiation of mechanical strength shall be provided for approval to demonstrate that the cabinet is free from distortion when equipment is mounted and supported on floor. All metallic cabinets shall have treatment for corrosion protection.

The dimensions of all cabinets shall be standardized as far as possible and without occupying excessive floor spacing.

Each UPS unit shall be constructed on a rigid base frame. Sub-assemblies and components shall be mounted on pull out and/or swing out trays- Cable connections

to the cable ladder and trays shall be of sufficient length to allow for easy access to all components.

Cabinets shall be of the freestanding floor mounting cubicle type. They shall be ventilated and vermin proof and shall provide easy access to all components for maintenance and replacement.

The UPS cabinet shall have a clear area of at least 1000 mm in front to allow the doors to be opened fully and maintenance to take place. Doors shall be fitted with lockable handles or other approved means of fastening and shall be provided with locking bars and guides to prevent distortion. Cabinet shall be arranged so that access doors or panels compartment can only be opened when the locking device is in the unlocked position. Two sets of keys shall be provided for each lock.

Means shall be provided for isolating individual units of equipment. Monitoring terminals or test jack points shall be provided for maintenance and testing.

Each Cabinet shall be fitted with metallic gland plates for entry of cables and an earth terminal. Foundation bolts and lifting hooks or eyes shall be provided as necessary for handling purposes. It shall be fitted internally with a nameplate, which shall state the manufacturer's name, serial number, rating and year of supply.

Danger warning notices with red letters on a white background shall be fitted to covers, which give access to live terminals or conductors at and above 110 volts. Circuit and function labels shall be provided. All labels shall be in Tamil, English and Hindi. On the enclosure a danger board should be provided as per Indian Electricity Rules.

Each of the items shall be adequately packed and protected against damage in transit from the manufacturer's work area to the Site. Similarly, after delivery to Site, each cubicle shall be properly protected from damage until work is completed.

Each UPS unit shall include an integral forced air-cooling system designed to ensure efficient removal of dissipated heat.

Each UPS unit shall be designed such that if there is a single fan failure or over temperature, an alarm shall sound, but it will in no way produce degradation of performance. In case of unavoidable shutdown due to excessive temperature rise, a warning alarm shall be given out before the shutdown.

All cabinets shall be solidly bonded to earth in accordance with BS 7430 using adequate section of cable or bus bar. The earth connection at the cabinets/enclosures shall be made to the frame earth provided or alternatively to a substantial part of the basic frame rather than a bolted - on panel.

The mechanical and electrical design of all cabinets shall be submitted for approval by the Engineer.

Each cubicle shall be fitted with a designation label to show the voltage rating and duty on the front and rear of the cubicle.

1.12.3.15 Electronic Components and Sub-Assemblies

Each printed circuit board shall be securely plugged into the UPS unit with guidance constructed inside UPS cabinet with easy access.

Printed circuit boards shall have sufficient thickness to ensure its mechanical rigidity and to eliminate the risk of damage during installation and maintenance. Dip switches shall be avoided as far as possible. Jumper wires shall be avoided. All PCB's used shall have G3 conformal coating and relevant test report certification as per ISA-71.04 shall be submitted.

Printed circuit boards shall be designed and manufactured to the accepted standards, which shall include standards for conductor thickness, width and spacing. Different standards shall be applied to equipment operated under different conditions if applicable.

All plug-in modules shall be clearly and unmistakably identified. Labelling with module name, part number, serial number and revision number shall be provided.

LEDs shall be provided with each plug-in module or printed circuit board to indicate the power supply and component fault status. They shall be easily visible without any obstructions.

All electronic modules, terminal blocks and other sub-assemblies shall be installed or mounted at a minimum height of 300 mm from the floor surface.

The rated voltage of insulated terminal blocks shall be 415 V between terminals, 240V to earth. Insulated terminal blocks shall comprise brass tubular connectors with screw connections contained within a moulded block suitable for working temperature up to 100°C.

Terminals shall be designed to clamp the conductor between metal surfaces with sufficient contact pressure but without causing damage to the conductor. With the largest recommended conductor in position, and tightly clamped, there shall be at least two full thread pitches of the screw engaging in the connector.

All materials and parts comprising the system shall be new and of current manufacture of a high grade and free from all known defects and imperfections.

All active electronic devices shall be solid state. All semi-conductor devices shall be hermetically sealed and with latest design procured from reputed manufacturer.

Terminals shall be supplied suitable for the cables being used to make the power connections. Terminals shall be provided for connecting the remote alarm contacts.

All power semi-conductors shall be fused in a manner to prevent cascaded or sequential semi-conductor failures. Indicator lamps denoting blown fuse conditions shall be located such as to be readily observable without removing panels or opening of the cabinet doors.

Isolating switches shall be of the load type with ON/OFF indication and lock attachment. Critical isolating switches essential for continuity of the load power shall be pad lockable.

Contactors shall conform to BS 775/ BS 62271. Contactor coils shall be suitable for

use on direct current. Rectifiers shall be of the selenium type and terminals shall be provided to external control of the contactors on the AC side of the rectifier.

1.12.3.16 Electrical Works and Accessories

All electrical equipment in the UPS, including MCCB, MCB, cable connector, trunking, conduit and other electrical accessories, shall comply with, the sections and clauses of this Specifications, relevant to these items. All the cables and wires used must be of Low Smoke Zero halogen type

Appropriate painting, finishes, adhesives, nameplates and labels shall comply with the relevant sections and clauses.

1.12.3.17 System Earthing

Two independent and distinct earth electrodes shall be provided for earthing of UPS connections comprising 25 x 6 mm CU wire / strips or as required / approved. Each of these earth electrodes shall comprise a copper plate as per Code of Practice for Earthing IS 3043-2018 (latest version).

1.12.3.18 Testing & Commissioning

The manufacturer of the UPS must have type test certificates, from an NABL accredited third party laboratory, for all the tests specified IEC 62040 – 3. In case, these are not available, manufacturer will be required to get these tests executed from NABL an accredited third-party laboratory.

Manufacturer will be required to carry out the routine and optional tests as specified in IEC 62040 – 3.

The UPS shall be thoroughly checked for correct operation and load tested in supplier's works before dispatch. All faults, control functions and site load conditions shall be simulated, checked and proved.

Each equipment shall be dispatched after testing in presence of authorized Engineer.

1.12.3.19 The Lithium Ion battery shall have the following test reports

Safety Certificate:

- Rack Level - UL 1998,991
- Battery Module & Switchgear - UL 1973 with each component level
- Cell Level – UL 1642
- EMC Test – IEC 61000-6-2, IEC 61000-6-4

Quality Certificate

- ISO 14001:2004 (Environment) & OHSAS 18001:2007 (Health & Safety)
- ISO 9001-2008

Seismic Test report (as per GR 63) for individual component – Rack, Module and Cell.

IEC 62619 Test Certificate

UPS and Lithium ion battery compatibility and verification test confirmation letter should be provided by the UPS vendor

1.12.3.20 Factory Acceptance Test for UPS

- Conduct physical test check for damages to system if any.
- Check component by component for likely damages during transit.
- Check for tightness of every component and internal wiring.
- Bidder shall furnish his quality assurance plan for the equipment offered.
- Conduct site tests vide technical specification.
- The vendor shall conduct all relevant tests (Acceptance Test) on UPS at their manufacturing plant and at site.
- System tests shall be performed on the completely assembled UPS system. System tests shall include Voltage regulation, harmonic content tests in addition to the tests to prove the functional requirements such synchronization with range of adjustments, transfer of static switches, overload and under voltage conditions.
- The complete assembled UPS system shall be operated at rated load under relevant ambient conditions for not less than 8 hours continuously prior to release for shipment and after installation at site.

Minimum tests to be conducted before dispatch at works in presence of Engineer:

- Load tests with resistive load.
- Overload load test
- 8 Hours -Heat run Test
- Measure THD levels at: 25%, 50%, 75% & 100% loads.
- Efficiency test 25%, 50%, 75% & 100% loads.
- Synchronizing test.
- 100% unbalance test.

These tests shall form part of this contract. The test results shall match with the technical requirements specified in the technical data sheet.

The tests will be witnessed by Engineer at works. The supplier shall provide advance information for pre dispatch tests conducted at works.

The Consultant / Engineer shall have the right to accept or reject the modules if it does not meet the technical requirements.

1.12.3.21 Factory Acceptance Test for Lithium ion batteries

Batteries shall be subject to inspection by Engineer or by an agency authorised by the Engineer, to assess the progress of work. The manufacturer shall furnish all necessary information concerning the supply to Engineer.

Engineer shall be given free access in the works from time to time for stage wise inspection and progress reporting. One-week advance notice shall be given to witness the final routine test and other test as agreed upon

Following test reports shall be submitted of the battery in accordance with IEC: 62281 & IEC: 62133

- External short circuit
- Abnormal charge
- Forced discharge
- Crush
- Impact
- Shock
- Vibration
- Heating
- Temperature cycling
- Low pressure
- Drop
- Continuous low rate charging

Following test is to be performed at Factory premises as per UL standard

- Over Voltage Protection
- Under Voltage Protection
- Battery Backup Time.
- Battery Charging duration
- Charge/Discharge Graph
- Individual Module data capture by Software

1.12.3.22 Site Acceptance Test

The following parameters shall be verified with external load bank at site against the approved guaranteed technical particulars:

- Input Voltage (V)
- Input Frequency (Hz)
- Input current THD (%)
- Output Voltage (V)
- Output Frequency (Hz)
- Output Current (A)

- Output Load (kW)
- Output Voltage THD (%)
- Battery Voltage (V)
- DC Battery time remaining
- Load tests with resistive load.
- Overload load test
- Measure THD levels at: 25%, 50%, 75% & 100% loads.
- Efficiency test 25%, 50%, 75% & 100% loads.
- Synchronizing test.
- 50% unbalance test.
- Min 8 Hours UPS Load test
- Battery Charging & discharge test

1.12.3.23 Documentation

The following data is required to submit

- General arrangement drawing of Battery module, single cell, complete battery rack
- Schematic drawing showing protection & control of entire battery bank
- Scheme drawing showing protection & control of battery module
- Battery module BMS, master BMS communication architecture
- Supporting testing reports for compliance
- Used switch gear component/device specifications
- List of companies in which modules supplied successfully and supporting reports including feedback forms
- Module protocol document
- Safety test reports
- EMI/EMC compliance document
- License free software for UPS and BMS
- Warranty certificate for UPS and Battery system
- Conformity from OEM for disposal of faulty batteries from site
- Environmental clearance from Local authority if required
- O&M manual for UPS & Battery system
- Operation, Installation and storage procedure
- Training programme for Engineer.

1.12.3.24 Packing and Shipping

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. Crates/cases shall have skid bottom for handling, Special notations such as 'Fragile', This side up 'Centre of gravity', 'Weights, 'Owner's particulars', SPO nos. etc., shall be clearly marked on the package together with other details as per purchase order.

The cells should be shipped with 30% or 50% charged state in module power off status during transportation. Avoid mechanical shock, crush, sun radiation and shower. Should be shipped by truck, train, ship or airplane etc.

To be filled by Vendor during submission of material approval:-

Sr. No.	Technical Parameter	Units	Specs	Compliance (To be filled by Manufacturer)
1	General Data			
1.1	Make of Battery	-	To be provided by Vendor	
1.2	Model No of Battery	-	To be provided by Vendor	
1.3	Technology	-	Li-NMC or Li-LMO & NMC	
1.4	Type of cell construction	-	Prismatic-Aluminium Can	
1.5	Cell configuration / arrangement in module	-	Series Only (1P, series only design)	
1.6	Cell, module protection details	-	NTC Thermistor, Pressure Valve	
1.7	Energy density	WHr/kg	Equivalent to 132 WHr/kG	
1.8	Cell internal pressure	Pa	To be provided by Vendor	
1.9	Cell, module heat during charge, discharge at full load	BTU	Per Module, Charging : 85.3 BTU Discharging : 1337.5 BTU	
1.10	Cycle life data	Years	10 Year, @30 deg, 80% DoD	
1.11	Cell, module weight	kg	To be confirmed by Vendor	
1.12	Module Size (LxBxH)	mm	To be confirmed by Vendor	
2	Materials of Construction	-		
2.1	Cathode material	-	Li-NMC /LMO&NMC	
2.2	Anode material	-	Carbon	

2.3	Electrolyte	-	LI Salt : LiPF6, Non Aqueous	
2.4	Body	-	Aluminium Can	
3	Electrical Parameters			
3.1	Maximum voltage of cell and module	V	4.15V, 58.1V	
3.2	Minimum voltage of cell and module	V	3.0V, 42.0 V	
3.3	Nominal voltage of cell and module	V	3.7V, 51.8V	
3.4	Capacity of cell and module	AH	50Ah or equivalent	
3.5	Cell, module impedance / resistance	Ohm	Cell : <0.7mΩ, Module : <22mΩ	
3.6	Continuous discharge / charge current	Amp	200 Amp / 50Amp (4C/1C)	
3.7	Maximum permitted charging rate	Amp	100 Amp, 2C Rate	
3.8	Ah, WHr efficiencies	%	Ah>99%, Wh>95%	
3.9	Module terminal maximum current capacity	A	300 Amp Constant	
3.10	Recharge profiles at different SOC levels	-	To be provided by Vendor	
3.11	Single Module Rating in Ah and kW	AH /KW	50 Ah /2.59 kWhr or Equivalent	
3.12	Cell Nominal Capacity	AH	50 Ah or equivalent	
3.13	Module Nominal Capacity	AH	50 Ah or equivalent	
3.14	Cell Nominal Voltage	V	3.7 V	

3.15	Module Nominal Voltage	V	51.8 V	
3.16	Cell Charging Voltage	V	4.0 V	
3.17	Module Charging Voltage	V	56.0 V	
3.18	Number Of Cells Per Module	Nos	To be filled by Vendor	
3.19	Cell Arrangement Per Module		Series connection 1P architecture only	
3.20	Internal Impedance / Resistance Cell and Module	Ohm	Cell : <0.7mΩ, Module : <22mΩ	
3.21	Maximum Allowed Modules In Series	Nos	16	
3.22	Type and Number of Temperature Sensor / Module and Location of Sensors In Module		14 Nos. of NTC Thermistor, per cell	
4	CONTROL BOX SPECIFICATIONS			
4.1	Required Hall Effect Current Sensor provided	Yes/No	To be confirmed by Vendor	
4.2	Device Used for Isolation of Battery System Like Relay, Fuse etc.	-	Relay (DC Contactor), & Fuse	
4.3	Isolation Device Voltage, Current Ratings	V/A	Relay : 1000V/500A, Fuse : 350A	
4.4	System Power On/Off Button/MCB rating	A	NA	

4.5	Required High Voltage Interlock Signal for Module provided	Yes/No	To be confirmed by Vendor	
4.6	Number Of Positive, Negative Terminals		1 Each	
4.7	Required Pre Charge Function/Relay provided	Yes/No	To be confirmed by Vendor	
5	Battery Cabinet			
5.1	Installation Capacity	kWH	25.9 kWhr * 2 Pack = 51.8 kWhr (Cabinet) or Equivalent	
5.2	Nominal Voltage	VDC	±259 VDC	
5.3	Maximum Voltage	VDC	±290 VDC	
5.4	Minimum Voltage	VDC	±210 VDC	
5.5	Charging Method	-	CC/CV	
5.6	Charging Voltage	VDC	±280.0 VDC	
5.7	Standard Charging Current Rate	Amp	50 A per pack, 100A per Cabinet	
5.8	Maximum Charging Current	Amp	100 A Per pack, 200A perCabinet	
5.9	Discharge Cut Off Voltage	VDC	±231 VDC	
5.10	Standard Discharging Current	Amp	120 A per pack, 240 A per Cabinet	2C
5.11	Maximum Discharging Current	Amp	540 A per pack, 1080 A per cabinet max 1 min	4C
5.12	Measurement Accuracy	-		
a	Voltage	%	Range of Values: 0 ~ ±500VDC Accuracy:	

			$\pm 1V(0... 100V)$, $\pm 1\%(>100V... 500V)$	
b	Current	%	Range of Values: 0 ~ $\pm 300A$ Accuracy: $\pm 0.5A(<=\pm 10A)$, $\pm 3\%(>\pm 10A)$	
c	Temperature	%	$\pm 2^{\circ}C$	
5.13	No. Of Module Per Cabinet	Nos	10 per pack, 20 per cabinet	
6	Performance			
6.1	Cycle Life of Battery @ 25 0C, 30 0C		@1C/1C rate	
a	50% DOD	Nos of Cycles	25°C : >8000 , 30 °C : >7000	
b	80% DOD	Nos of Cycles	25°C : 5500 , 30 °C : 4500	
c	100% DOD	Nos of Cycles	25°C : 2800 , 30 °C : 2200	
6.2	Preferred Depth Of Discharge		80%	
6.3	Minimum No. of Cycles at		@1C/1C Rate	
a	80% DOD @25 0C	No of Cycles	>5500 Cycles	
b	80% DOD @30 0C	No of Cycles	>4500 Cycles	
6.4	Energy	kWH	2.59 kWhr per Module	
6.5	Specific Energy	Kwh/Kg	88.7 Wh/kg per module	
6.6	Ah Efficiency at different SOC% Range (i.e. 0-100, 20-100, 50-100)	%	>99%	
6.7	Wh Efficiency at different SOC% Range (i.e. 0-100, 20-100, 50-100)	%	>95%	

6.8	Recharge Profile In different Rate (i.e. at 0.3c,0.5c,1c) of Charging at Different SOC % Levels (i.e. at 0-100, 0-80)		To be provided by Vendor	
6.9	Discharge Profile in different Rate (i.e. at 1c, 2c, 4c, 6c) Of Discharge at different SOC% Levels (i.e. 100-0, 100-20)		To be provided by Vendor	
6.10	Cycle Life Data @ 1c Discharge 1c Charge, Cycling Between		To be provided by Vendor	
6.11	50-0% SOC		To be provided by Vendor	
6.12	100-50% SOC		To be provided by Vendor	
6.13	Capacity Retention Ratio		80%	
6.14	Pluggable Design	Yes/No	To be confirmed by Vendor	
6.15	Continuous Charging Current at 1C	Amp	50 Amp per module	
6.16	Continuous Discharging Current at 2C	Amp	100 Amp per module	
6.17	Maximum Charge current and Duration	Amp, s	100 A Constant, per pack	
6.18	Maximum Discharge current and Duration	Amp	540 A per pack, 1080 A per cabinet max 1 min	
6.19	Battery Cabinet Power Density		259 Watt/ kg @ 4c rate	

6.20	Self-discharge / Week		<0.2%	
6.21	Maximum Number Of Modules Supported By BMU for Series Connection	Nos.	16	
6.22	Does Product have 10 years of Calendric Life @ 25 0C, 30 0C @95%Rh @ 80% EOL	Yes/No	To be provided by Vendor	
6.23	Maximum Allowable Ambient Temperature at Which Cell Can Safely Operate	0C	Charge : 0 to 45, Discharge -20 to 55	
6.24	Recommended Maximum Period of Storage Without Recharge at 30 0C, 40 0C	days	6 Months @ 25±5 °C, 2 Months @ 40°C	
6.25	Voltage Ripple Allowable	%	5%	
6.26	Maximum Internal Pressure that Cell can sustain	Psi	0.7 Mpa	
6.27	Short Circuit Capacity	Ka	200 kA	
6.28	Total Heat Emission Under Full Load Condition	Kw	0.4 kW per modules	
6.29	Battery Voltage Variation	%	<0.2%	
6.30	Recover Time After discharge @ 0.3C Charging current			
a	50% DOD	hours	1.5 Hrs.	
b	80% DOD	hours	2.5 Hrs.	
c	100% DOD	hours	3 Hrs.	

6.31	Air-Conditioning Requirement		No	
6.32	Cooling Period After One Discharge Cycle at Max Charging Rate	hours.	NIL	
7	Construction and Dimensions			
7.1	Module Enclosure Material	-	SGCC	
7.2	Module Enclosure Paint Shade	-	Same as UPS enclosure shade	
7.3	IP rating of Module Enclosure	-	IP 20	
7.4	Control Box Rack Enclosure Material	-	SGCC	
7.5	Control Box Rack Enclosure Paint color (RAL No)	-	Natural Color	
7.6	IP rating of Control Box Rack Enclosure	-	IP 20	
7.7	Connection Cable / Bus bar Current Rating and Size	-		
a	Connection From Module To Control Box	Amp, mm ²	Uninyvin Grade 2	
b	Connection From Control To Ups Dc Bus	Amp, mm ²	Uninyvin Grade 2	
7.8	Is High Voltage DC Bus Interconnection on Rear side of Rack?	Yes/No	To be confirmed by Vendor	
7.9	Is Battery and Control	Yes/No	To be confirmed by	

	Box modular in design		Vendor	
7.10	Battery Module Weight	Kg	29.2 Kg (Approx.)	
7.11	Battery Module No of Positive, Negative Terminals	Nos	1 Each	
7.12	Module Power On/Off Buttons provided	Yes/No	To be confirmed by Vendor	
7.13	Control Box Weight	Kg	To be confirmed by Vendor	
7.15	Total Battery Bank Weight	Kg	To be confirmed by Vendor	
7.16	Max Battery Dimensions (W X D X H)	mm	To be confirmed by Vendor	
7.17	Max Control Box Dimensions (W X D X H)	mm	To be confirmed by Vendor	
7.18	Overall Dimension Of Total Cabinet (W X D X H)	mm	To be confirmed by Vendor	
8	Battery Management Unit			
8.1	Does BMU have Capability to Sense and Cut off Battery Module During Following Conditions			
a	Over Voltage	Yes/No	To be confirmed by Vendor	
b	Over Current	Yes/No	To be confirmed by Vendor	
c	Over Temperature	Yes/No	To be confirmed by Vendor	
d	Cell Unbalances	Yes/No	To be confirmed by Vendor	

8.2	What is the type of Communication Port (RS 485/ Ethernet/ CAN/USB)		CAN 2.0B/RS485 MODBUS	
8.3	Type Of Connector, No Of Connector On Module		JWT C2522H02-12P	
8.4	Type Of Connector, No Of Connector On BMU		DINKLE 2EHDP-24P	
8.5	Is each Cell In Battery Equipped With Following Extra Protection			
a	Internal Pressure	Yes/No	To be confirmed by Vendor	
b	Over Temperature	Yes/No	To be confirmed by Vendor	
8.6	Control Supply Of BMU/Module		External, 24VDC (AC/DC Converter)	
8.7	Is required Cell Equalization feature provided in each module	Yes/No	To be confirmed by Vendor	
8.8	Is Cell Series Connection not Directly Through BMS PCB (To avoid Propagation to Cells In Case Of Short Circuit and / Or Over Heat)	Yes/No	To be confirmed by Vendor	
8.9	Required BMU Sleep Mode Enable provided	Yes/No	To be confirmed by Vendor	
8.10	BMU Power	W	1.6 Watt	

	Consumption During Normal Operation			
8.11	BMU Power Consumption During Sleep Mode	W	5 mWatt (OFF Mode)	
8.12	Is required PCB Conformal Coating provided	Yes/No	To be confirmed by Vendor	
8.13	Is required Data Recording Feature for Alarm and Parameters provided	Yes/No	To be confirmed by Vendor	
8.14	Is Data Recording Frequency min. 60 minutes with circular storage buffer FIFO format	Yes/No	To be confirmed by Vendor	
	Does it have Data Recording		To be confirmed by Vendor	
8.15	Capacity for minimum 1 year	Yes/No		
8.16	Provide Protocol Type (Modbus RTU / ASCII/CAN 2.0)	-	MODBUS RTU/CAN2.0 B	
8.17	Minimum Duration Between Two Consecutive Pooling by Controller To Battery BMU	ms	100mS	
8.18	Does it provide required Module Cumulative kWhr	Yes/No	To be confirmed by Vendor	
8.19	Does it provide required Module 80% DOD Cycle Life Count	Yes/No	To be confirmed by Vendor	
9	BMU Protection Values			

	and Range			
9.1	Cell Over Voltage Warning	V	4.10	
9.2	Cell Over Voltage Protection	V	4.15	
9.3	Cell Over Voltage Recovery	V	4.00	
9.4	Cell Under Voltage Warning	V	3.30	
9.5	Cell Under Voltage Protection	V	3.00	
9.6	Cell Under Voltage Recovery	V	3.40	
9.7	Rack Over Voltage Warning	V	287.0	
9.8	Rack Over Voltage Protection	V	290.5	
9.9	Rack Over Voltage Recover	V	280.0	
9.10	Rack Under Voltage Warning	V	231.	
9.11	Rack Under Voltage Protection	V	210.0	
9.12	Rack Under Voltage Recovery	V	238.0	
9.13	Rack Over Current Discharge Warning	A	290.0	
9.14	Rack Over Current Discharge Protection	A	300.0	
9.15	Rack Over Current Discharge Recovery	A	280.0	
9.16	Rack Over Current Charge Warning	A	105.0	

9.17	Rack Over Current Charge Protection	A	120.0	
9.18	Rack Over Current Charge Recovery	A	100.0	
9.19	Cell Discharge Over Temperature Warning	0C	55	
9.20	Cell Discharge Over Temperature Protection	0C	60	
9.21	Cell Discharge Over Temperature Recovery	0C	45	
9.22	Cell Discharge Under Temperature Warning	0C	-22	
9.23	Cell Discharge Under Temperature Protection	0C	-25	
9.24	Cell Discharge Under Temperature Recovery	0C	-17	
9.25	Cell Charge Over Temperature Warning	0C	55	
9.26	Cell Charge Over Temperature Protection	0C	60	
9.27	Cell Charge Over Temperature Recovery	0C	45	
9.28	Cell Charge Under Temperature Warning	0C	-2	
9.29	Cell Charge Under Temperature Protection	0C	-5	
9.30	Cell Charge Under Temperature Recovery	0C	3	
9.31	Equalization Enable Criteria	Conditions	Floating Charging or Rest when BMS judge cell unbalance over 50mV, Balance current 50mA	

9.32	Equalization Mode Applicable	Charging / Discharging	Charging	
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1.12.3.25 Requirement for Communication with Local/Remote Monitoring System

As a minimum following shall be made available for local/remote monitoring of Batteries and cells. Battery Manufacturer may suggest additional parameters that may be necessary to monitor for better performance of the system. All I/O required for the monitoring shall be made available.

SI. No	Parameters to be Monitored	Manufacturer's Confirmation/Proposal
A	Following Alarm and Status Information Need To be Provided BMU Wise	
1	Over Voltage Warning	Yes
2	Under Voltage Warning	Yes
3	Over Temperature Warning	Yes
4	Under Temperature Warning	Yes
5	Charge Over Current Warning	Yes
6	Discharge Over Current Warning	Yes
7	Cell Unbalance Warning	Yes
8	Ground Fault Protection	Yes
9	Over Voltage Protection	Yes
10	Under Voltage Protection	Yes
11	Over Temperature Protection	Yes
12	Under Temperature Protection	Yes
13	Charge Over Current Protection	Yes
14	Discharge Over Current Protection	Yes
15	Unbalance Protection	Yes
16	Permanent Fail Protection	Yes
17	Power Off	Yes
18	Power On	Yes

19	Pre-charging	Yes
20	Rest/Float	Yes
21	Discharging	Yes
22	Charging	Yes
23	Protection Mode	Yes
B	List Of BMU Parameter For Remote Monitoring	
1	Charging Current, Amp	Yes
2	Discharging Current, Amp	Yes
3	System SOC, %	Yes
4	Max Cell Voltage, VDC	Yes
5	Min Cell Voltage, VDC	Yes
6	Max Cell Temperature, °C	Yes
7	Min Cell Temperature, °C	Yes
8	System Bus Voltage, VDC	Yes
9	System Rack Voltage, VDC	Yes
10	System Power, kW	Yes
11	Rack Design Capacity, AH	Yes

Offer include Approvals, supply, installation, commissioning and testing of UPS system as per below:			
1	Supply of Batteries	Yes/No	
2	Battery Cables	Yes/No	
3	Lugs and Heat Shrink Sleeves	Yes/No	
4	Hardware (Nuts/bolts/washers)	Yes/No	
5	Battery Racks, Anchor bolts, cage nuts/bolts etc.)	Yes/No	
6	Supply of Rack/Cabinet complete with accessories	Yes/No	
7	Spares for Installation, Commissioning and Start- up	Yes/No	
8	Spares recommended for 2 years of operation	Yes/No	

9	FAT, packing, transportation and delivery to site, installation supervision, SAT, Testing, Commissioning, Training and handover.	Yes/No	
10	Engineering documentation and its approval through electronic transmittals	Yes/No	

1.12.3.25 **Guarantee / Warranty Criteria**

- a) For ensuring the guaranteed life of UPS & batteries from the Contractor/OEM, “ The Contractor shall submit the BG (5 years) of 10% of the actual invoiced value of supply of UPS & Batteries or 10% of 60% of BOQ cost, whichever is higher, before completion of DLP period for the remaining guarantee/ warrantee period left. For this, the Contractor shall have to enter into separate Supplementary Agreement with CMRL Authorities after completion of DLP.”
- b) One month prior to expiry of BG, UPS & Batteries shall be jointly inspected at site by Contractor and CMRL Representative and required testing will carried out as per SAT and the testing may be witnessed by CMRL Representative.
- c) Warranty certificate for UPS (5 years) & Batteries (10 years) to be submitted seperately as mentioned in the specification.

a) Criteria for Acceptance

- UPS & Batteries shall be verified before end of warranty period and Tests to be performed as per OEM & CMRL approved format and routine test parameters specified by OEM.
- Batteries should have remaining capacity of 70-80% of BoL (Beginning of Life) at end of warranty period.

1.12.3.26 **Performance Parameters:**

The output of UPS system will be used by Signalling & Train Control system, Telecommunication system and Automatic Fare Collection system, Platform Screen Door/Gate, & E&M and any break in power supply to these systems may lead to disruption in train services and/or other operational complexities. Therefore, it must be understood that Quality of UPS Output, Reliability and Availability requirements of the UPS system are of paramount importance.

Any break in power supply to Signalling & Train Control system, Telecommunication system and/or Automatic Fare Collection system, Platform Screen Door/Gate & E&M caused due to any failure of the UPS or associated sub-systems during the Defect Liability Period, may call for imposition of penalty of Rs. Two Lacs per such event on the Contractor.

2.6.8 PRE-ACTION SYSTEM

Description.

- 2.6.8.1 This specification outlines the requirements for a supervised Double-Interlocked Electric / Pneumatic or (Nitrogen air) Release Pre-action Systems.
- 2.6.8.2 The small profile, lightweight, pilot operated Model
- 2.6.8.3 The system piping is pressurized with air or nitrogen to serve both as a means of supervising the integrity of the piping network and as one portion of the system release operation.
- 2.6.8.4 This feature serves to prevent undetected leaks on the system piping network. If the system piping or a sprinkler is damaged, the supervisory pressure is reduced, and a "low air" supervisory alarm is activated.
- 2.6.8.5 Double interlocked electric/pneumatic release pre-action systems require the use of one 24 VDC normally closed (NC) electric solenoid and one pneumatic actuator or (Nitrogen air) The electric solenoid is connected to a compatible release control panel and compatible detection devices.
- 2.6.8.6 The pneumatic actuator is controlled by the air pressure that is contained within the sprinkler system piping. In fire conditions, both the solenoid and a sprinkler must open in order for the Valve to operate. When both the solenoid and pneumatic actuator open, the priming water is relieved from the internal prime chamber assembly. The prime chamber assembly collapses, and water passes through the Valve and internal check diaphragm to the system piping network. The entire sprinkler system fills with water.
- 2.6.8.7 Double interlock electric/pneumatic release pre-action systems are commonly used in cold storage applications and other areas where it is important to control accidental water discharge due to inadvertent damage to the sprinkler piping

2.6.8.8 Ordering Information:

- 2.6.8.8.1 Double Interlock Electric/Pneumatic Pre-action Riser Assembly

2.6.8.9 INSTALLATION:

a. General Installation Instructions

- 2.6.8.9.1 For proper operation and approval, the valve must be installed in the vertical position as trimmed from the factory. DO NOT modify the factory assembled trim except as described in this technical data sheet.
- 2.6.8.9.2 A 2" section of pipe is provided with the Double Interlock Electric / Pneumatic Pre-action Riser Assembly. Prior to valve maintenance, this section of pipe may be removed to provide clearance for lifting the cover from the body.
- 2.6.8.9.3 The Valve must be installed in an area not subject to freezing temperatures or pu physical damage. If required, provide a valve house (enclosure) with adequate heat around the Valve and trim. Freezing temperatures will damage the Valve. When corrosive atmospheres and/or contaminated water supplies are present, it is the owner's responsibility to verify compatibility with the Valve and associated equipment.

b. Air Supply Design

1. Air Compressor Size

- (i) Recommends tank-mounted air compressors for Double Interlock Electric/Pneumatic Release Pre-action Systems. The pneumatic actuator requires at least 30 PSI (2.1 bar) of air pressure be established within the piping network for systems with water pressure up to 175 PSI (12.1 bar) and 50 PSI (3.45 bar) of air pressure for systems with water pressures up to 250 PSI (17.2 bar). NFPA 13 requires the air supply to be capable of filling the entire sprinkler system to its required air pressure within 30 minutes.

2. Nitrogen Cylinder Gas Supply

- a. Nitrogen may be used in place of air compressors. Nitrogen is supplied in pressurized cylinders in various sizes and pressures. Some of the most common are 122 Cu. Ft. at 1,900 PSI (3,455 L at 131 bar), 225 Cu. Ft. at 2,100 PSI (6,372 L at 145 bar), and 280 Cu. Ft. at 2,300 PSI (7,930 L at 159 bar). When nitrogen cylinders are used as a primary air supply, spare cylinders should be furnished and located at the valve location.
- b. Special attention must be given to systems employing a bottled-gas supply. Because only a limited amount of gas is available, small leaks (which normally would go unnoticed in systems being supplied by mechanical compressors) can become critical to the system's overall performance. If the system is to function at temperatures as low as -40 °F (-40 °C), and, if bottled nitrogen is the gas supply, the system is particularly susceptible to leakage, and special care should be taken to ensure against leaks throughout the entire system.

c. FIELD ADJUSTMENTS:

- a. Alarm Pressure Switch: The operating point of the switch can be adjusted to any point between 4 PSI (0.27 bar) and 8 PSI (0.55 bar) by turning the adjustment knob(s) clockwise to raise the actuation point or counter-clockwise to lower the actuation point.
- b. Air Supervisory Switch : The operating point of the switches can be adjusted to any point between 10 PSI (0.7 bar) and 60 PSI (4.1 bars) by turning the adjustment knob(s) clockwise to raise the actuation point or counter-clockwise to lower the actuation point. The high and low switches are adjusted independently.

d. Air Supply Installation

1. Install the required air supply as described in section 4.B. The size of the compressor and amount of air required should be determined in accordance with Tables 1, 2 & 3. The air or nitrogen supply to the pre-action system must be clean, dry, and oil free.
2. Automatic air supplies must be regulated, restricted, and from a continuous source. Air Maintenance Device should be installed on each system equipped with a tank mounted compressor, plant air or nitrogen. For compressors with a capacity less than 5.5 ft³/min at 10 PSI (0.154 m³/min at 0.69 bar), NFPA 13 does not require an air maintenance device. The use of an air maintenance device with riser mounted compressors can lead to compressor "short cycling" that a

tank-mounted compressor with air maintenance device be used. This can become critical when accelerators are installed on the system.

e. Pressure Switch Wiring.

1. Wire the Alarm Pressure Switch (PS10) and Air Supervisory Switch (PS40), and adjust the pressure settings.

f. Hydrostatic Test:

1. The Pre-action System, including Sprinkler Piping and Sprinklers shall be hydrostatically tested at 200 PSI (13.79 bar) and maintained for two hours, in accordance with NFPA 13. Systems normally subjected to working system pressures in excess of 150 PSI (10.34 bar) shall be tested at a pressure of 50 PSI (3.45 bar) in excess of system working pressure.

g. Placing the Valve in Service:

When the Pre-action System is ready to be placed in service, verify that the pneumatic release system is in a normal condition and that the electric release system has been reset.

1. Verify that the water supply main control valve (not shown) supplying the Valve is closed.
2. Close the prime valve.
3. Open the main drain valve.
4. Open the flow test valve.
5. Drain all water from the pre-action system. If the system has operated, or if water has entered the system, allow enough time to completely drain the system.
6. Close the main drain valve.
7. Open the priming valve. Prime water pressure will enter and expand the valves internal diaphragm assembly onto the valve seat, effectively closing the valve. Verify prime pressure has been established on the prime pressure gauge.
8. Establish air pressure on the system.
9. Verify that no water flows from the drip check when the plunger is pushed.
10. When the priming pressure has been verified as being established, slowly open the water supply control valve (not shown).
11. When flow is developed from the flow test valve, CLOSE the flow test valve.
12. Fully open the water supply main control valve.
13. Secure all valves in their normal operating position.

14. Reset the release control panel.
15. Notify Authorities Having Jurisdiction and those in the affected area that the system is in service.
16. The system is now fully operational.

h. Operational Test:

1. An operational test shall be performed on the system in accordance with NFPA 13. Refer to Section 6 for Inspection and Operation Test Procedures.

2.6.8.10 OPERATION

2.6.8.10.1 In the Set position:

- a. When air pressure is introduced into the sprinkler piping, the sensing end of the pneumatic actuator is pressurized. This closes the pneumatic actuator. The closed pneumatic actuator and the normally closed solenoid valve prevent prime water from escaping the prime chamber of the Valve. When prime water enters the prime chamber, the rolling diaphragm is pressurized, causing it to expand downward onto the water seat.

2.6.8.10.2 Fire Condition:

- a. When the detection system operates, the normally closed solenoid valve is powered open. At this point, the prime water is still held in the prime chamber by the closed pneumatic actuator. When a sprinkler operates, air pressure is lost on the sensing end of the pneumatic actuator, causing the pneumatic actuator to open. With both the pneumatic actuator and solenoid valve open, prime water is drained from the prime chamber, causing the Valve to open, filling the sprinkler piping with water. Water from the intermediate chamber of the Valve pressurizes the sensing end of the PORV, causing the PORV to open. The open PORV prevents water pressure from building in the prime chamber should the solenoid or pneumatic actuator close.

2.6.8.11 INSPECTION AND OPERATIONAL TEST

2.6.8.11.1 OPERATING CONDITION. It is imperative that the system is inspected and tested on a regular basis in accordance with NFPA 25. The frequency of the inspections may vary due to contaminated water supplies, corrosive water supplies, corrosive atmospheres, as well as the condition of the air supply to the system. For minimum maintenance and inspection requirements, refer to NFPA 25. In addition, the Authority Having Jurisdiction may have additional maintenance, testing, and inspection requirements that must be followed.

A. Low Air Pressure Alarm Test:

Quarterly testing of low air alarms is recommended.

To Test Sprinkler System "Low Supervisory Air" Alarm:

1. To prevent operation of the Valve and filling the system with water during the test, DO NOT operate the electric detection system during test. Consider closing the main water supply control valve.

2. Fully open the sprinkler system test connection.
3. Verify that low air alarms operate within an acceptable time period and continue without interruption.
4. Close the test connection.
5. Establish recommended pneumatic supervisory pressure to be maintained. Refer to section 4. INSTALLATION.
6. Reset the system release control panel. Alarms should stop.

B. Full Flow Trip Test:

Performance of a trip test is recommended annually during warm weather. Consider coordinating this test with operation testing of the detectors.

To Trip Test the Electric / Pneumatic Double-Interlocked Pre - action System:

1. Notify the Authority Having Jurisdiction and those in the area affected by the test.
2. Trip the Valve by performing option "a" or "b" below.
 - a. Operate the electric release control system according to the manufacturer's instructions and open the sprinkler system test connection.
 - b. Operate the emergency release valve.
3. The Valve should open, filling the sprinkler system with water. Water flow alarms should operate.
4. Verify that there is adequate flow from the sprinkler system test valve.

2.13.8.14 Air Aspiration Detection System

2.13.8.14.1 General (UL Listed System Components)

- a. The detector shall consist of highly sensitive laser-based/laser-imaging based smoke detection chamber with aspirators connected to a piping network.
- b. The system shall be of a type submitted to, tested, approved and/or listed by UL (Underwriters Laboratories, Inc.), FM (Factory Mutual), VdS (EN54-20), CE, ActivFire, AFNOR, VNIPO and local codes and standards.

2.13.8.14.2 System Description

- a. Highly sensitive laser-based/laser-imaging based smoke detection chamber, aspirating fan, and inbuilt filter. Filter shall be continuously monitored for usage to automatically notify about filter replacement overriding the user configured interval, if any. For Non Airconditioned/Dusty applications, provision shall be available to connect inline filters on the sampling pipe in addition to the inbuilt filter.
- b. Each detector shall be provided with LED indications/LCD Touchscreen colour display feature with sounder. The system shall allow programming of four smoke threshold alarm levels; time delays; faults including airflow, detector, power and filter. Seven inbuilt configurable relay outputs for remote indication of alarm and fault conditions. In case of multizone detector, dedicated relay outputs shall be available for notification of at least 2 stages of alarm per zone. Detailed fault information should be reported in the fire alarm panel without requirement of additional hardware.
- c. Air sampling pipe network to transport air to the detection system. The detector shall have single/four-in-line sample pipe inlets and must contain a flow sensor for each pipe inlet. Flow fault thresholds shall be configured for each pipe independently. For better proactive maintenance the blockage/breakage should be reported in 4 stages (2 stages for low flow & 2 stages for high flow) to plan maintenance schedule effectively. Configuration shall support configuration of delay to report flow fault. Airflow fault information should be reported in the fire alarm panel without requirement of additional hardware.

2.13.8.14.3 Performance Requirements

- a. All model selection should be validated using flow calculation for suitability & compliance to relevant international standards with respect to transport time & sampling hole sensitivity.
- b. Approved to provide very early smoke detection and provide four output levels corresponding to Alert, Action, Fire 1 and Fire 2. These levels should be able to be set at sensitivities ranging from 0.025% obscuration per meter to 20% obscuration per meter. All stages of alarms should be reported in the fire alarm panel without requirement of additional hardware.
- c. Report any fault on the unit by using configurable fault output relays as well as seamlessly on main fire alarm control panel

- d. Self-monitoring for filter and detector contamination. User shall be able to check the usage (contamination) of filter at any point of time. Reuse of choked filter should be rejected by the detector.

2.13.8.14.4 System Components

- a. Detector Assembly: The detection chamber, filter and aspirator shall be housed in a mounting box and shall be arranged in such a way that air is drawn from the fire risk area by the aspirator.
- b. The detection chamber shall be laser-based/laser-imaging based type and shall have an obscuration sensitivity range of 0.025 - 20 % / meter.
- c. The detector shall also incorporate facilities to transmit detector fault and air flow fault conditions using relays as well as seamlessly to main fire control panel without additional hardware
- d. The inbuilt filter shall remove the dust contamination from the sampled air. Detection chamber should incorporate mechanism for clean air to prevent the detection chamber optics from contamination to preserve the sensitivity & reliability over a long period. Relative algorithms that continuously adjusts the alarm thresholds automatically based on perceived environmental conditions to compensate for chamber contamination shall not be considered.
- e. The aspirator motor shall purpose-built rotary vane air pump, allowing for multiple sampling pipes runs from 50 to 90 meters. each, with a response maximum 60 seconds.
- f. The assembly shall contain relays for alarm and fault conditions. The relays shall be software programmable to the required functions specific to the Contractor, applicable to the authority having jurisdiction.
- g. The assembly shall be either surface mounted to a wall or recess mounted in a wall cavity.
- h. The system shall have built-in data and event logging, as and when the event occurs at user specified time intervals, with up to 18,000 events of storage per detector (zone). The detector shall support logging of detailed events including smoke levels, flow levels, user actions, real time filter usage and fault information

2.13.8.14.5 Programming & central monitoring

- a. Software package for central monitoring and configuring the detectors shall be placed in Fire Control Room It shall meet all local codes, standards, and regulations.
- b. The monitoring and configuration of detectors shall be through personal computer and allowing the monitoring and configuration through single/multiple interfaces HLI (High level interface) and system nets.
- c. The software support local and remote password-based access control.
- d. The software shall have user friendly graphic user interface.

- e. The system shall be suitable for multiple languages including English with conversion facility from one language to other.
- f. It shall provide event list which includes fault, trouble and alarm across multiple locations. Shall be capable of acknowledging the events and resetting the devices.
- g. The software shall provide printing of event lists.
- h. The software shall connect directly to system net through necessary links and connectors. The PC shall interpret status change data transmitted from ports and provide graphic annunciation, control history, logging and reports. Network system with use of dry contacts or voltage monitoring interfaces to connect to ASD System network shall not be accepted.
- i. The system shall be able to connect to remote sites via IP based LAN or WAN using virtual serial port.
- j. The system shall communicate to detectors through RS-232/RS 485 or equivalent. It shall have ability to transfer all events to network control station.
- k. The system shall enable floor plan drawings, to be used in software, to graphically notify user where a smoke event is occurring. It shall allow development of multiple levels of interconnected floor plans. The system shall allow incorporation of Auto-cad, jpg, bmp and other common image files.
- l. The system shall allow for multiple device smoke trending on single graph.
- m. The system shall support sophisticated event log management functionality.
- n. Event logs from all networked detectors shall be able to be retrieved, viewed & stored in a ODBC compliant database
- o. The software shall operate on window TM 11 professional or latest and shall interface with desktop of network control station (NCS).

2.13.8.14.6 Device Networking Requirements

The devices in the smoke detection system shall communicate with each other via twisted pair RS-485 cable. The network shall support up to 200 devices.

2.13.8.14.7 Detection Alarm Levels

The laser based aspirating detection system shall have independently programmable levels of alarm. The alarm level function and alarm settings shall be determined by risk area and shall be finalized by contractor or his authorized representative at the time of installation and commissioning in consultation with Employer/ Employer Representative as per site condition & sensitivity requirement

Alarm delays shall be configured, if required, up to 60 secs for each stage of alarm

Provision shall be available for the user to initiate a self-learning mode that

ensures the best selection of appropriate alarm thresholds & flow fault threshold thresholds. Systems which continuously adjust alarm & flow fault thresholds without user knowledge shall not be considered.

Provision shall be available to configure the system to adjust smoke level reading to avoid nuisance alarms when there is possibility of smoke entering the room from external sources like fresh air intake grills

2.13.8.14.8 Sampling Pipe Design

The sampling pipe network shall be arranged to provide optimum efficiency. The response react time for the least favourable sampling point in the system shall not exceed 60/90 seconds for critical applications dictated by codes & standards and the system shall be balanced so that the volume of air drawn from the last sampling point shall not be less than 70% of the volume from the first sampling point to avoid some part of room being very sensitive while other part is not sensitive.

The Sampling pipe network shall have the capability to take air samples in variable pressure conditions & in environments with very high ACH from a range of 10 to 100Pa and for air changes as high as 250ACPH.

The Contractor shall furnish details of the pipe work design showing the proposed layout and the design shall be supported by computer-generated calculations showing response react time, suction pressure, sensitivity for each sampling point and balance details along with compliance to relevant standard applicable for the critical application.

Applicable Standards (to be considered as per application)

- NFPA 72
- NFPA 76
- BS5839
- BS6266

2.13.8.14.9 System Checks

Pipe Installation

Ensure that all joints, fittings, bends, sampling points, etc., comply with the specification & are installed properly.

Detector Configuration

- Alarm threshold levels (for both day and night settings),
- Time delays,
- Pipes used in case of detector with multiple pipe inlets
- Detector address,
- Display address where applicable,
- Clock time and date,
- Air flow fault thresholds,
- Reset / Disable button operable,

- Touch screen operable where applicable,
- All warning devices operate as required
- Integration with Fire Alarm Control Panel to ensure correct operation.
- But not limited above.,

2.13.8.14.10 Final Tests

The contractor shall:

- Verify that the response react time from the nearest, middle & farthest sampling hole does not exceed 20% variation as per the response react time in flow calculation using a smoke signal rise displayed.
- Conduct BS6266 hot wire smoke test to confirm the performance of the installed Aspiration system.
- Activate the appropriate Fire Alarm zones and advise all concerned that the system is fully operational.

5.11.14 Programmable logic controller- CPU:

The CPU shall be Flexibility, Robustness, Sustainability and Ethernet backbone to optimize connectivity and communications. CPU's shall support Non Safe I/O modules. The powerful processors offer high levels of computation for complex networked communication, display and control applications.

The processor shall be having the following.

- a. CPU shall support minimum 5000 IO points with extended Rack capacity.
- b. CPU can be configured along with Remote I/O's
- c. Top to bottom standard Ethernet Network with OFC communication port compatibility.
- d. Open architecture with direct ethernet connection on backplane.
- e. Shall be internal architecture as per the OEM proprietary.
- f. CPU shall have built in cybersecurity features and it shall be level-2 security certifications.
- g. Embedded security features as defined by standard IEC 62443.
- h. Remote access to PLC can be controlled.
- i. Implementation of standard IPSEC protocol helps to secure communication between control network and PLC/devices.
- j. External fire wall will be placed between the Depot and OCC operations and SMS and Mail alerts.
- k. Based on high speed dual core processor
 - l. The processor shall be high speed communication, application and execution.
- m. The processor shall be handle of innovative mechanical and electronic design for high EMC immunity and ruggedness that is superior to the required IEC standard.
- n. CPU supports ambient temperature range from 0deg C to +50 Deg C.
- o. CPU shall be high precision.
- p. Native Deterministic ethernet network.
- q. Ability to deliver 10mS I/O resolution through native time stamping at source specific time stamping modules via OPC server.
- r. Application specific functions shall include as
 1. Sequence of event recording
 2. Protective relay trip history
 3. Alarm/event log history
 4. Time stamping of power monitoring data logs
 5. Time stamping of internal data

- s. The system flexibility topology allows simple integration of devices.
- t. The cpu shall be, ability to mix remote equipment, distributed equipment and other devices on same ethernet field network with complete software integration.
- u. Transparent access to data through ethernet backbone.
- v. Simple HMI integration via third port on remote I/O head
- w. Interface to other popular fieldbus and device networks including interface Modbus, Profibus and HART.
- x. Easy diagnosis features shall be included in CPU and System architecture.
- y. Simple, remote and mobile diagnosis features shall be available.
- z. Embedded web server for web access.
- aa. Manage supervision screens on HMI and access HMI screens.
- bb. Clear distinction between safety and process shall be available in the CPU.
- cc. All modules, backplane, VFD supports, PLC programming software supports, SCADA Support, Server supports, HMI support shall be considered for the PLC part.
- dd. High-available field buses – for reliable communication from the field devices to the controller via distributed I/O
- ee. Trouble-free replacement of all components during operation
- ff. Changes to the configuration possible during operation
- gg. Early detection of faults and integrated diagnostics options
- hh. No loss of data in the event of a fault.
 - ii. The level of fault tolerance can be perfectly tailored to the requirements by mixing single and double redundancies in the same system and coordinating them with each other.
- jj. CPU shall support above features and not limited to.

- 5.11.14.1 Non SIL PLCs shall be supplied by a manufacturer of international repute with a proven track record of similar installation applications.
- 5.11.14.2 PLC configurations shall be completely modular, DIN rail mounting, and compact in construction to ensure maximum optimisation of cabinet space without compromising environmental operating conditions. There shall be a range of expansion I/O modules available for different signal requirements such that a vertically integratable cost/performance configuration is realized for each location.
- 5.11.14.3 PLCs shall be supplied and installed for control & monitoring of equipment. It shall consist of microprocessor-based processor (CPU), Input and output interface modules suitable for a mixture of digital, analog and pulse inputs and outputs.
- 5.11.14.4 The PLCs shall permit reconfiguration by the Employer of all facilities, including but not limited to: Scan frequency, Signal priority, Analogue alarm level adjustment, Signal classification, Addition and removal of I/O, I/O assignment, Automatic control sequences.
- 5.11.14.5 PLC to be programmed as per Operation Philosophy/ISMS System requirements. Based on that PLC has to function. PLC shall support Remote IO Configuration.
- 5.11.14.6 All the modules (including CPU) of the PLC Platform shall be HOT Swappable i.e., on Power ON condition: Modules can be plugged into or out of the rack without any damage to or electrical noise. No output shall be affected while replacing these modules.
- 5.11.14.7 The PLC processor shall have the ability to receive and map signals from third party systems over Modbus RS485 protocol, BACnet, Modbus TCP/IP/Profinet. Interface to other popular fieldbus and device networks including Modbus, Profibus, BACnet and HART.
- 5.11.14.8 The PLC should have the capacity to be monitored over an Ethernet network. The PLC processor shall be able to monitor its resident I/O while also being able to communicate with a SCADA network over an Ethernet network.
- 5.11.14.9 The PLC application development environment shall be compatible to IEC61131-3 latest standard and the software shall be coded by either one of the standard languages, as defined in IEC61131-3.
- 5.11.14.10 The PLC shall be application-software controlled, with the software assembled from proven software modules, and shall be capable of the following function and facilities:
 - a. Local time-tagging of events.
 - b. Alarm handling from discrete inputs and derived parameters.
 - c. At least two adjustable alarm levels for both positive and negative excursions of all analogue signals, with adjustable dead band.
 - d. Combining of binary inputs Boolean functions to give conditional outputs.
 - e. Communication by serial link to other processor-based equipment using one or more standard open, synchronous or asynchronous serial interface protocols.

- 5.11.14.11 The equipment shall be self-monitoring for fault conditions and shall generate an alarm on the appropriate operator workstations in the event of a fault arising.
- 5.11.14.12 Facilities shall be provided for routine servicing and re-configuring of PLC software by the Employer. PLC software shall be capable of being reconfigured, under password control, either locally from the portable-programming device to be supplied under the Contract, or remotely over the communications links from operator workstations.

5.20 BMS Workstation for Elevated Stations.

5.20.1 The primary operator interface shall be workstation with ultra-high-resolution LED color graphics display(s). Workstation shall have monitors each with diagonal measurement of at least 24 inches with state of art; however, the dimension shall be subject to NONO from Employer/Engineer based on the screen frame display shots proposed by the Contractor. Tilt and swivel facilities shall be provided. The number of VDU's can be two (2) or more but the number of VDUs for each workstation shall be sufficient to allow a comprehensive set of information to be displayed. Operating systems based on a Graphical User (GUI) format incorporating the widely used WIMPs procedures (windows, icons, menus, pointing device), where one display can overlay another shall be provided. WYSIWYG (what- you-see-is-what-you-get) display printing and print previewing features shall be provided. 32" diagonal LED monitors supporting 4k resolutions with Monitor stands for vertical mounting of LED displays.

5.21 Workstation - CPU

5.21.1 Workstation CPU hardware shall have minimum 50,000 hours MTBF value. It shall have an MTTR of 30 minutes. This time shall not include the time taken for a technician to arrive at the initial reported failure site.

5.21.2 The minimum hardware configuration of operator workstation-CPU shall be:

S.NO.	EQUIPMENT	DESCRIPTION
a.	Processor	Intel core i9 Processor with 3.0 GHZ or latest one
b.	RAM	Minimum 16 GB or latest as per system requirement
c.	Hard Drives	Minimum 1 TB Memory (Hard disk drive)
d.	Graphic Cards	Minimum 8GB memory, supporting necessary dual monitor configuration
e.	Ethernet Ports	Dual 10/100/1000Mbps Ethernet Ports
f.	DVD Drive	48x24x48 DVD-R/W drive
g.	Ports	Parallel, serial and USB ports to accommodate printers, mouse, and other peripherals
h.	USB Ports	Minimum 2 External ports with enable/disable option. Shall have physical lock facility for USB ports.
i.	Operating System	64-bit Windows-11 Professional or latest

5.22 L2 Switch – Un Managed Switch

5.22.1 The layer-2 Unmanaged switches used at each station shall be redundant, configured so failure of one switch causes seamless handover to the other switch. L2 Unmanaged Switch should have both Ethernet & FO Port, port quantity as per design requirement/BOQ. It should be designed for Industrial environments.

- 5.22.2 The layer-2 Switch shall have IEEE compliant for 802.1Q VLAN, 802.1p, 802.1d STP, 802.1x user authentication, SNMP v1, v2, v3; Telnet, CLI support for in-band and out-of-band management, minimum of 8.8Gbps Forwarding Bandwidth, minimum of 6 Mbps forwarding rate.
- 5.22.3 The layer-2 Switch shall support Link Aggregation for increasing Backbone bandwidth, four queues per egress port, Port Security, MAC Address Notification, IGMP Filtering, embedded Remote Monitoring (RMON) software agent supports four RMON groups (history, statistics, alarms, and events) for enhanced traffic management, monitoring, and analysis, IGMP snooping for multicast and streaming traffic, spanning tree enhancements such as BPDU Guard, Root Guard, etc. to avoid denial of service attacks.
- 5.22.4 Support for feature like Uni-Directional Link Detection or equivalent. In case of one of the fibers is cut, the access switches should detect uni-directional transmission and shut down the port to avoid loops and help bring up the backup links.
- 5.22.5 The Layer-2 access switches shall be able to segregate collision domains between each local VLAN.
- 5.22.6 The Layer-2 access switches shall support the following management Standards: SNMPv1/2/3 and MIB II : RFC1213
- 5.22.7 The layer-2 switches shall have dual redundant power source to meet the full power requirements including the fully expandable future load



CHENNAI METRO RAIL LIMITED

CHENNAI METRO RAIL PROJECT PHASE 2, CORRIDOR 4

TENDER No. C4-E&M-05

Supply, installation, testing commissioning and training of Electrical, Fire protection and VAC works for 18 Elevated stations from Power House Station to Poonamallee Bypass station including Viaduct between the stations (Ch 10027.102 to Ch 25928.186), approach ramp, including Poonamallee Depot for Corridor 4 of Chennai Metro Rail Project Phase-II

PART - 2

EMPLOYER'S REQUIREMENTS

SECTION VI D – EMPLOYERS DRAWINGS

MARCH 2022

SI No.	Clause No. ITB/GCC/SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No
1.	Part 2 Section VI D, Employer Drawing	<p>Drawing List</p> <p>DDC-P2C4-05-MEP-DR-DEP-63001-01-A</p> <p>DDC-P2C4-05-MEP-DR-SSG-63001-01-A</p> <p>DDC-P2C4-05-MEP-DR-SAN-63001-01-A</p> <p>DDC-P2C4-05-MEP-DR-SCB-63001-01-A</p> <p>DDC-P2C4-05-MEP-DR-SPH-63001-01-A</p> <p>DDC-P2C4-05-MEP-DR-SVP-63001-01-A</p> <p>Electrical Schematics</p> <p>DDC-P2C4-05-MEP-DR-DEP-63003-01-A</p> <p>DDC-P2C4-05-MEP-DR-DEP-63003-02-A</p> <p>DDC-P2C4-05-MEP-DR-DEP-63003-03-A</p> <p>DDC-P2C4-05-MEP-DR-DEP-63003-04-A</p> <p>DDC-P2C4-05-MEP-DR-DEP-63003-05-A</p> <p>DDC-P2C4-05-MEP-DR-SSG-63004-01-A</p> <p>DDC-P2C4-05-MEP-DR-SAN-63004-01-A</p> <p>DDC-P2C4-05-MEP-DR-SCB-63004-01-A</p> <p>DDC-P2C4-05-MEP-DR-SPH-63004-01-A</p> <p>DDC-P2C4-05-MEP-DR-SVP-63004-01-A</p> <p>DDC-P2C4-05-MEP-DR-SVP-63004-02-A</p> <p>Lightning Protection Layouts</p> <p>DDC-P2C4-05-MEP-DR-SSG-63431-01-A</p> <p>DDC-P2C4-05-MEP-DR-SAN-63531-01-A</p> <p>DDC-P2C4-05-MEP-DR-SCB-63531-01-A</p> <p>DDC-P2C4-05-MEP-DR-SPH-63531-01-A</p> <p>DDC-P2C4-05-MEP-DR-SVP-63531-01-A</p>	<p>Please refer Addendum Drawing Annexure-13</p> <p>Drawing List</p> <p><u>DDC-P2C4-05-MEP-DR-DEP-63001-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SSG-63001-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SAN-63001-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SCB-63001-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SPH-63001-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SVP-63001-01-B</u></p> <p>Electrical Schematics</p> <p><u>DDC-P2C4-05-MEP-DR-DEP-63003-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-DEP-63003-02-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-DEP-63003-03-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-DEP-63003-04-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-DEP-63003-05-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SSG-63004-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SAN-63004-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SCB-63004-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SPH-63004-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SVP-63004-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SVP-63004-02-B</u></p> <p>Lightning Protection Layouts</p> <p><u>DDC-P2C4-05-MEP-DR-SSG-63431-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SAN-63531-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SCB-63531-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SPH-63531-01-B</u></p> <p><u>DDC-P2C4-05-MEP-DR-SVP-63531-01-B</u></p> <p>DG Room Layout</p> <p><u>DDC-P2C4-05-MEP-DR-DEP-63852-02 - A</u></p>	<p>Amended as Underlined</p> <p>SI. No74, 95, 102,132,271,272, 366, 367, 381, 368, 369, 446, 447, 448, 449, 453, 454, 455, 456</p>

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No
2.	Part 2 Section VI D, Employer Drawing	As per Schematic Diagram: BMS SCHEMATIC DIAGRAM DDC-P2C4-05-MEP-DR-DEP-68002-01-A	Please refer Addendum Drawing Annexure-13 <u>BMS SCHEMATIC DIAGRAM</u> <u>DDC-P2C4-05-MEP-DR-DEP-68002-01-B</u>	Amended as Underlined Sl. No 280, 285
3.	Part 2 Section VI D, Employer Drawing	Poonamallee Depot IO Summary DDC-P2C4-05-MEP-DR-DEP-68270-01-A ELEVATED STATIONS BMS I/O SCHEDULE DDC-P2C4-05-MEP-DR-C4E-66001-01-A	Please refer Addendum Drawing Annexure-13 Poonamallee Depot IO Summary <u>DDC-P2C4-05-MEP-DR-DEP-68270-01-B</u> ELEVATED STATIONS BMS I/O SCHEDULE <u>DDC-P2C4-05-MEP-DR-C4E-66001-01-B</u>	Amended as underlined. Sl. No 318, 349
4.	Part 2 Section VI D, Employer Drawing	Fire Fighting Drawings DDC-P2C4-05-MEP-DR-DEP-62001-01-A DDC-P2C4-05-MEP-DR-DEP-62003-01-A DDC-P2C4-05-MEP-DR-DEP-62003-02-A DDC-P2C4-05-MEP-DR-DEP-62003-03-A DDC-P2C4-05-MEP-DR-C4D-62001-01-A DDC-P2C4-05-MEP-DR-C4D-62001-02-A DDC-P2C4-05-MEP-DR-SCB-62001-01-A DDC-P2C4-05-MEP-M3-SCB-62501-01-A DDC-P2C4-05-MEP-M3-SCB-62602-01-A DDC-P2C4-05-MEP-DR-SPH-62001-01-A DDC-P2C4-05-MEP-M3-SPH-62602-01-A DDC-P2C4-05-MEP-DR-SSG-62001-01-A DDC-P2C4-05-MEP-M3-SSG-62501-01-A DDC-P2C4-05-MEP-M3-SSG-62602-01-A DDC-P2C4-05-MEP-DR-SVP-62001-01-A DDC-P2C4-05-MEP-M3-SVP-62601-01-A DDC-P2C4-05-MEP-DR-C4E-62001-01-A	Please refer Addendum Drawing Annexure-13 Fire Fighting Drawings <u>DDC-P2C4-05-MEP-DR-DEP-62001-01-B</u> <u>DDC-P2C4-05-MEP-DR-DEP-62003-01-B</u> <u>DDC-P2C4-05-MEP-DR-DEP-62003-02-B</u> <u>DDC-P2C4-05-MEP-DR-DEP-62003-03-B</u> <u>DDC-P2C4-05-MEP-DR-DEP-62651-01-A</u> <u>DDC-P2C4-05-MEP-DR-C4D-62001-01-B</u> <u>DDC-P2C4-05-MEP-DR-C4D-62001-02-B</u> <u>DDC-P2C4-05-MEP-DR-SCB-62001-01-B</u> <u>DDC-P2C4-05-MEP-M3-SCB-62501-01-B</u> <u>DDC-P2C4-05-MEP-M3-SCB-62602-01-B</u> <u>DDC-P2C4-05-MEP-DR-SPH-62001-01-B</u> <u>DDC-P2C4-05-MEP-M3-SPH-62602-01-B</u> <u>DDC-P2C4-05-MEP-DR-SSG-62001-01-B</u> <u>DDC-P2C4-05-MEP-M3-SSG-62501-01-B</u> <u>DDC-P2C4-05-MEP-M3-SSG-62602-01-B</u> <u>DDC-P2C4-05-MEP-DR-SVP-62001-01-B</u> <u>DDC-P2C4-05-MEP-M3-SVP-62601-01-B</u> <u>DDC-P2C4-05-MEP-DR-C4E-62001-01-B</u>	Amended as underlined. Sl. No 262, 314, 385, 387 to 390

Sl No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query Sl. No
		DDC-P2C4-05-MEP-DR-C4E-62001-02-A	<u>DDC-P2C4-05-MEP-DR-C4E-62001-02-B</u>	
5.	Part 2 Section VI D, Employer Drawing	Depot VAC Layout and Section DDC-P2C4-05-VAC-DR-DEP-69001-01-A DDC-P2C4-05-VAC-DR-DEP-69450-01-A DDC-P2C4-05-VAC-DR-DEP-69451-01-A DDC-P2C4-05-VAC-DR-DEP-69451-02-B	Please refer Addendum Drawing Annexure-13 Depot VAC Layout and Section <u>DDC-P2C4-05-VAC-DR-DEP-69001-01 -B</u> <u>DDC-P2C4-05-VAC-DR-DEP-69450-01-B</u> <u>DDC-P2C4-05-VAC-DR-DEP-69450-02-A</u> <u>DDC-P2C4-05-VAC-DR-DEP-69451-01-B</u> <u>DDC-P2C4-05-VAC-DR-DEP-69451-02-B</u>	Amended as Underlined Sl. No 240

PLEASE REFER TO BELOW LINK FOR PART-2 EMPLOYERS REQUIREMENTS SECTION VI D–EMPLOYERS DRAWINGS

LINK:

Station & Depot Drawings:

[C4-E&M-05 Tender Addendum drawings](#)

Addendum Drawing

Drawings can be downloaded from the above link.

THE DRAWINGS ARE INDICATIVE AND FOR TENDER PURPOSE ONLY

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CHENNAI METRO RAIL LIMITED

CHENNAI METRO RAIL PROJECT PHASE 2, CORRIDOR 4

TENDER No. C4-E&M-05

Supply, installation, testing, commissioning and training of Electrical, Fire protection and VAC works for 18 Elevated stations from Power House Station to Poonamallee Bypass station including Viaduct between the stations (Ch 10027.102 to Ch 25928.186), approach ramp, including Poonamallee Depot for Corridor 4 of Chennai Metro Rail Project Phase-II

PART - 3

**CONDITIONS OF CONTRACT AND CONTRACT
FORMS**

MARCH 2022

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No
1.	Part 3: Section VIII Clause 7 Page 1712 of 1752	1.1.3.15 Add a new Sub-Clause 1.1.3.15: "Factory Tests" means the tests required to be carried out in the factory premises on components, equipment, subsystem, system, etc. during and/or after manufacture in the factory.	<u>1.1.3.13</u> Add a new Sub-Clause <u>1.1.3.13</u> : "Factory Tests" means the tests required to be carried out in the factory premises on components, equipment, subsystem, system, etc. during and/or after manufacture in the factory.	Amended as underlined. SI. No 358
2.	Part 3: Section VIII Clause 8 Page 1712 of 1752	1.1.3.16 Add a new Sub-Clause 1.1.3.16: "Integrated Testing" means the programme of tests performed by the Contractor at the direction of the Engineer/Employer following satisfactory completion of Contractor's tests on his equipment, sub-systems or system to verify and confirm the compatibility and compliant performance of his equipment/sub-system/system with the equipment/sub-system/system provided by others.	<u>1.1.3.14</u> Add a new Sub-Clause <u>1.1.3.14</u> : "Integrated Testing" means the programme of tests performed by the Contractor at the direction of the Engineer/Employer following satisfactory completion of Contractor's tests on his equipment, sub-systems or system to verify and confirm the compatibility and compliant performance of his equipment/sub-system/system with the equipment/sub-system/system provided by others.	Amended as underlined. SI. No 358
3.	Part 3: Section VIII Clause 33 Page 1723 of 1752	5.2 Contractors Documents The reference of "approval" from the Engineer, wherever specified in entire tender document is changed as "Notice of No Objection".	<u>4.25</u> Contractors Documents The reference of "approval" from the Engineer, wherever specified in entire tender document is changed as "Notice of No Objection".	Amended as underlined.

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No
4.	Part 3: Section VIII Clause 34 Page 1723 of 1752	<p>5.4 Technical Standards and Regulations Add the following at the end of 1st paragraph: The Design and construction standards to be adopted by the contractor shall be in conformity with the Requirements of “Metro Railway Act for opening of Metro Railway for Public carriageway of Passengers, Rules” (along with amendments), “Metro Railway General rules, 2020” (along with amendments), “Rules for opening of a Railway or a section of a Railway for Public Carriage of Passengers” and “Rules for introduction of New type of Rolling stock” and to the satisfaction of the commissioner of Metro Railway Safety whose sanction is mandatory for commissioning of the system. Sanction of the Commissioner of Metro Railway Safety and other Statutory Authorities will be required for introduction of the systems. The contractor shall in this regard carry out all statutory tests and trials necessary for obtaining sanction of the Competent Authority for opening the system for public carriage of passengers and provide assistance and information as required by the appropriate statutory authorities in India. The contractor under the supervision of the Engineer shall also carry out all tests and trial runs and prepare reports and documents required for obtaining all approvals and sanctions of the Commissioner of Metro Railway Safety (CMRS) and any other statutory Authority.</p>	<p><u>4.26</u> Technical Standards and Regulations The Design and construction standards to be adopted by the contractor shall be in conformity with the Requirements of “Metro Railway Act for opening of Metro Railway for Public carriageway of Passengers, Rules” (along with amendments), “Metro Railway General rules, 2020” (along with amendments), “Rules for opening of a Railway or a section of a Railway for Public Carriage of Passengers” and “Rules for introduction of New type of Rolling stock” and to the satisfaction of the commissioner of Metro Railway Safety whose sanction is mandatory for commissioning of the system. Sanction of the Commissioner of Metro Railway Safety and other Statutory Authorities will be required for introduction of the systems. The contractor shall in this regard carry out all statutory tests and trials necessary for obtaining sanction of the Competent Authority for opening the system for public carriage of passengers and provide assistance and information as required by the appropriate statutory authorities in India. The contractor under the supervision of the Engineer shall also carry out all tests and trial runs and prepare reports and documents required for obtaining all approvals and sanctions of the Commissioner of Metro Railway Safety (CMRS) and any other statutory Authority.</p>	Amended as underlined. SI. No 395

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No
5.	Part 3: Section VIII Clause 35 Page 1723 of 1752	5.6 As-Built Documents Add the following at the end of Sub-clause 5.6: The Contractor shall submit Six (6) copies of As-built documents and O&M Manuals to the Engineer/the Employer for 'Notice of No Objection'.	<u>4.27</u> As-Built Documents The Contractor shall submit Six (6) copies of As-built documents and O&M Manuals to the Engineer/the Employer for 'Notice of No Objection'.	Amended as underlined. SI. No 395
6.	Part 3: Section VIII Clause 36 Page 1723 of 1752	5.7 Operation and Maintenance Manuals Add the following at the end of Sub-Clause 5.7: The Operation and Maintenance manuals and drawings submitted by the Contractor shall, if required, be updated by him during the Defects Notification Period and be resubmitted for review by the Engineer.	<u>4.28</u> Operation and Maintenance Manuals The Operation and Maintenance manuals and drawings submitted by the Contractor shall, if required, be updated by him during the Defects Notification Period and be resubmitted for review by the Engineer.	Amended as underlined. SI. No 395
7.	Part 3: Section VIII Clause 49 Page 1728 of 1752	8.4.1 Extension of time for completion for other reasons Any extension to a Key Date shall not by itself entitle the Contractor to an extension to any other Key Date and the Time for Completion. A delay analysis with all facts are to be submitted along with any EOT claim.8	8.4.1 Extension of time for completion for other reasons Any extension to a Key Date shall not by itself entitle the Contractor to an extension to any other Key Date and the Time for Completion. A delay analysis with all facts are to be submitted <u>along with any EOT claim.</u>	Amended as underlined. SI. No 397

SI No.	Clause No. ITB/GCC/ SCC/Forms	As Existing	As Amended	Remarks/ Pre-Bid Query SI. No
8.	Part-3: Section VII Page 1735 of 1752	<p><u>Replace Sub-Clause 14.7 with the following:</u></p> <p>Payment of the amount due in specified currency or currencies shall be made into the account opened exclusively at Chennai by the Contractor with any Public Sector Bank (PSB) or Scheduled Commercial Bank for the operation of funds in this project and all payments by Employer shall be credited only to such account. CMRL will audit such accounts quarterly.</p> <p>Contractor cannot divert amounts from this account for executing other projects until the completion of this work</p>	<p><u>Add the following at the end of Sub-Clause 14.7</u></p> <p><u>(d) Payment of the amount due in specified currency or currencies shall be made into the account opened exclusively at Chennai by the Contractor with any Public Sector Bank (PSB) or Scheduled Commercial Bank for the operation of funds in this project and all payments by Employer shall be credited only to such account. CMRL will audit such accounts quarterly. Contractor cannot divert amounts from this account for executing other projects until the completion of this work</u></p>	Amended as underlined. SI. No 303