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FIGURES:-

FIGURE 1: Typical Interface & Installation Requirements of Drainage Sump Pumping System for Stations

FIGURE 2: Typical Interface & Installation Requirements of Sewage Ejector Pumping System for Stations

TABLES:-

TABLE 1: ISCS Interface Point

11 E&M WORKS

11.1 General

11.1.1 The Supply and Installation of all Electrical and Mechanical Works shall form part of the scope of Works under this Contract.

11.1.2 The Electrical Works involves coordination, supply, installation, testing and commissioning of touch voltage protection, earthing, equipotential bonding and stray current corrosion control for Siglap Station as detailed and described in the LTA Civil Design Criteria for Road & Rail Transit Systems, M&W Specification and Technical requirements for Shelters, Fire Safety and Shelter Department.

11.1.3 The Mechanical Works involves coordination, supply, installation, testing and commissioning of water services, fire hydrant, sewerage and sanitary works, drainage sump pumping system for Siglap Station as detailed and described in the LTA Civil Design Criteria for Road & Rail Transit Systems, M&W Specification and Technical requirements for Shelters, Fire Safety and Shelter Department.

11.1.4 Multi Cable Transit (MCT) will be supplied and installed by the Contractor for all services penetration for cable lead-in pipes and services through and above CD doors. The Contractor shall coordinate with all SWCs for the location, sizes and quantities including the facing of MCT.

11.2 Platform Touch Voltage Protection

11.2.1 The Contractor shall provide touch voltage protection in accordance to the specification and design requirement as specified in the Drawings and Chapter 13 of the LTA Civil Design Criteria for Road & Rail Transit Systems and Chapter 25 of the M&W Specification for Civil & Structural Works.

11.2.2 The Contractor shall refrain from designing fire rated end return door within the touch voltage protection zone.

11.2.3 General Requirements

- (a) At the edge of platform in the station on the Thomson-East coast Line, Platform Screen Doors (PSD) separates the passengers from the tracks. The PSD are connected to earth through the rails so that they are connected to a separate earth from the station but the same earth as the electric trains;

- (b) Should there be an electrical fault and the train bodies or doors be connected to the electric operating system, passengers alighting from the train and touching the PSD would not form a separate circuit. However, if these passengers were able to touch parts of the station structure or finishes that were connected to the earth of the station, they would complete a circuit with the PSD or Train and could suffer from electric shocks. These electric shocks are termed touch voltage; and
- (c) Therefore, the Contractor is required to provide an effective system to insulate the finishes and structures (including floors, walls and columns) that fall within the protected zone. The finishes and structures shall be electrically isolated from earth, or provided with a suitable isolation coating, to avoid harmful touch potentials.

11.3 Earthing System

11.3.1 General Requirements

- (a) The Earthing System is indicated in the Drawings.
- (b) The Contractor shall carry out individual soil resistivity test at each end of the station prior to construction of the station base slab.
- (c) The soil resistivity test shall use the Wenner 4-pin method and the results to be submitted by the Contractor shall be reviewed and endorsed by a Registered Electrical PE. The Contractor shall select a minimum of two (2) test locations for each earth mat/pit area subject to the approval of the Engineer. Five sets of tests shall be conducted at each location; each set at pin spacing of 2m, 4m, 6m, 8m and 10m respectively. The Contractor shall submit the results to E1006 for design verification and modification.
- (d) The supply, installation and testing of the earthing system shall be in accordance with SS CP5, SS 551 and ANSI/IEEE standards. The passing criteria for earthing resistance for each earth mat system shall be not more than 1Ω .
- (e) The Contractor shall prepare the necessary detailed working drawings and test procedures and submit to the Engineer for approval. The earth mat, earth electrode, earth risers and earth inspection pits shall be provided by the Contractor.

- (f) If the Contractor is not able to achieve earthing resistance of less than 1 ohm after his installation of the earth mat system, he shall carry out the necessary remedial works to achieve the required earthing resistance. The Contractor shall coordinate with E1006 to propose the necessary remedial works and submit to the Engineer for acceptance. All the necessary remedial works to be carried out by the Contractor shall be deemed to be included in this Contract.

11.3.2 Contractor Installation and Execution

- 11.3.2.1 Earth Electrode Pit Systems shall be provided at ground level, in compliance with SS 551:2009 requirements.
- 11.3.2.2 Earth Mat Systems shall be installed underneath the station box. The earth mat shall comprise a network of earth rods and bare copper tapes laid 300mm below the underplatform slab / ground level. Connections between earth rods and bare copper tapes shall be by exothermic welding (or equivalent) and must be inspected by the Engineer before backfilling.
- 11.3.2.3 185mm² low smoke zero halogen insulated copper cable earth risers shall be connected from the earth mat up through the underplatform slab to the equipment rooms indicated on the earthing schematic diagrams. Two (2) 95mm² low smoke zero halogen insulated copper cable on cable tray shall be connected from the earth mat to two (2) test locations located above ground at station entrance area. Each earth riser will have a separate inspection pit cast-in in the under platform slab.
- 11.3.2.4 At each riser cable entry through the base slab a tinned copper water-stop sleeve shall be provided to prevent the ingress of water. The sleeve shall be coated with epoxy resin and be provided with all round hydrophilic or equivalent water stop.
- 11.3.2.5 The Contractor shall coordinate with other SWC and SWC (Electrical Services) for termination of the earth riser cables onto the main earth bars.
- 11.3.2.6 The copper conductors at the earth inspection chamber at ground level shall have a label "Electrical Earth - Do Not Remove".
- 11.3.2.7 All underground cables crossing driveways or hardcore areas shall be provided with heavy duty UPVC pipes encased in concrete with full haunching.

11.3.3 Testing

11.3.3.1 The Contractor shall carry out the following earthing mat tests:

- (a) Individual earthing mat test at each end of station;
- (b) Combined earthing mat/pit test;
- (c) Continuity test after earth risers are terminated on earth bars, and
- (d) Final earthing mat/pit test

11.3.3.2 The test method statements shall be submitted to the Engineer for approval prior to carrying out of the test. All test method statement and reports shall be endorsed by the Electrical PE.

11.3.3.3 The Contractor's Electrical PE shall submit six (6) original copies of endorsed earthing certificate (Declaration of the Earthing System), test report/ results and As-built Drawings to the Engineer prior to the commissioning of station power supplies.

11.3.3.4 The Contractor shall provide labels next to the earth bars indicating the test dates, test conditions and test results of the earthing resistance.

11.4 Stray Current Corrosion Control

11.4.1 General Requirements

- (a) The provision of Stray Current Corrosion Control shall meet the following objectives:
 - (i) To ensure a 120-year design life for railway structures.
 - (ii) To provide facilities to monitor and mitigate the stray current effects on the structures.
- (b) The Contractor shall employ a specialist contractor for the supply, delivery and installation, testing and commissioning of zinc reference electrode, termination boxes and associated cables and accessories.
- (c) The Contractor shall evaluate the requirements for Stray Current Corrosion Control within his design, coordinate with all relevant interface details with all necessary parties and produce working drawings for the approval of the Engineer.

11.4.2 The Contractor shall provide Stray Current Corrosion Control in accordance to the specification and design requirement as specified in the Drawings, LTA Civil Design Criteria for Road & Rail Transit Systems and M&W Specification for Civil & Structural Works.

11.4.3 **Reference Electrodes**

11.4.3.1 Reference electrodes to be provided by the Contractor are shown in the Drawings.

11.4.3.2 Reference electrode shall be made of high purity zinc, pre-packaged in a special backfill, and provided with a reference electrode wiring cable to reach the reference cell termination box without intermediate joints.

11.4.3.3 Each electrode terminal shall be covered by a suitable terminal box for protection. The terminal box shall be of stainless steel material and of IP65 construction with removable box cover.

11.4.3.4 Reference electrode wiring shall have an insulation level of 1.8/3kV and be single core, multi-stranded copper conductor and XLPE insulated.

11.4.4 **Testing and Commissioning**

11.4.4.1 The types, methods, procedures of the tests and measurements shall be submitted to the Engineer for approval prior to conducting the tests. All test instruments and measurement charts are to be provided by the commissioning party.

11.4.4.2 Upon completion of a commissioning test, a test inspection certificate endorsed by the Contractor's PE shall be submitted for the Engineer's acceptance.

11.5 **Equipotential Bonding (EPB)**

11.5.1 General Requirements

(a) The Singapore Standard for electrical systems (CP5) requires all metallic components in the station that could be subject to connection to electrical current to be separately bonded to the common earth of the station. This earth bonding is known as equipotential bonding (EPB).

(b) The Civil Contractor and all SWC are required to comply with the Singapore Standard CP5.

- 11.5.2 The Contractor shall provide EPB in accordance to the specification and design requirement as specified in the Drawings, SS CP5, SS551 and the LTA Civil Design Criteria for Roads & Rail Transit Systems.
- 11.5.3 All metallic components in the station are to be connected to the station earth in accordance with Singapore Standard CP5. Table 1 in Chapter 13 of the LTA Civil Design Criteria for Roads & Rail Transit Systems gives particular requirements relating to the station components.
- 11.5.4 The basis for the scope of work of EPB provision is that whoever provides the said equipment or services shall also be responsible for providing the EPB, which shall include the design submission, endorsement and the submission of As-built Drawings.
- 11.5.5 Where EPB provisions are identified to be required in Table 1 of Chapter 13 of the LTA Civil Design Criteria for Roads & Rail Transit Systems, the Contractor shall provide the supplementary bonding to the nearest EPB conductor. The Contractor shall engage an Electrical PE for the certification of the complete EPB system.
- 11.6 Water Services, Sewerage and Sanitary Works and Station Drainage Sump Pumping System**
- 11.6.1 The Contractor shall provide the supply, installation, testing and commissioning of the complete Water Services, Sewerage and Sanitary Works and Station Drainage Sump Pumping System in accordance to the specification and design requirement as specified in the Tender Drawings, Civil Design Criteria for Roads & Rail Transit Systems, and the M&W Specification for Civil & Structural Works
- 11.6.2 The SWC for the supply and installation of Water Handling Equipment (WHE) shall be called by the Authority.
- 11.6.3 The Contractor shall submit the as-built drawings, calculation of the operating pump head and flow rate based on the site coordinated pipe works routing and characteristic of the entire station pipework system pipework for Engineer's acceptance and procurement of Water Handling Equipment (WHE).
- 11.6.4 The Contractor shall engage a QP/License Plumber (LP) for the above works.

11.6.5 Water Services

11.6.5.1 The domestic water installation shall comply with the latest Singapore Standard CP48, the Authority and other relevant local authority / statutory boards.

11.6.5.2 The private fire hydrant system installation, if any, shall comply with the Singapore Standard 575, Fire Safety and Shelter Department of SCDF and other relevant local authority / statutory boards.

11.6.6 Sewerage & Sanitary Works

11.6.6.1 The sewerage and sanitary works installation shall comply with the latest Code of Practice on Sewerage and Sanitary Works from PUB, the Authority and other relevant local authority/ statutory boards.

11.6.7 Station Drainage Sump Pumping System

11.6.7.1 The station drainage sump pumping system shall comply with the latest Code of Practice on Surface Water Drainage from PUB, the Authority and other relevant local authority/statutory boards.

11.7 Interface Requirements

11.7.1 E&M Interfaces

11.7.1.1 The Contractor shall coordinate will all SWCs on the confirmation of concrete plinth provisions for E&M equipment mounting/ OG box fixing, slab and wall openings for services penetrations as shown in the SEM Drawings.

11.7.1.2 The Contractor shall coordinate with the SWC (Electrical Services) for:

- Underground cabling at ground level for all cast-in pipes, in particular, the cable lead-in pipes
- Embedded cross-track cable troughs and cast-in pipes at underplatform level and track level
- Authority and utility civil work requirements
- Multi cable transit (MCT) units for cable penetrations above CD doors and services lead-in pipes
- Lamp pole fixing and mounting, etc.

- 11.7.1.3 Isolators and associated cabling from the power supply source to the isolators or fuse connection units for various equipment such as dewatering pumps, drainage sump pumps, sewage ejector pumps, toilet sensors, shutters, etc. shall be provided by the SWC (Electrical Services). The Contractor shall coordinate with the SWC (Electrical Services) regarding the exact locations of the isolator mountings on the wall and related cable routings.
- 11.7.1.4 The Contractor shall coordinate with the SWC (Environmental Control System) on the location of the isolation valves for the water supply connection to the feed and expansion tank and cooling tower make-up water transfer tank.
- 11.7.1.5 The Contractor shall coordinate with the SWC (Fire Protection System) on the location of the isolation valves for the water supply connection to the combined fire sprinkler/cooling tower make-up water tank and direct feed to the hose reel system.
- 11.7.1.6 The Contractor shall coordinate with the SWC (Water Handling Equipment) on all relevant matters relating to the supply and installation of WHE including but not limited to the locations of the pumps and pump discharge connections, PMCP, sump pit and pump sump cover requirement. The typical interface and installation requirements of the sewage ejector pumping system and drainage sump pumping system and tunnel sump pumping system are indicated in Figures 1 to 2 respectively.
- 11.7.1.7 The Contractor shall conduct site coordination and provide attendance to SWC (WHE) for the installation of all equipment including to those in tunnels. The contractor shall take lead to resolve any interfacing issue between WHE, and to make adjustment to his provisions to suit the connection to the WHE and other installations.
- 11.7.1.8 The Contractor's QP/LP (Licensed Plumber) shall be responsible for the submission to the relevant local authority and complete installation, testing and commissioning of the water services, sewerage and sanitary works and drainage systems including WHE.
- 11.7.2 **Information Exchange**
- 11.7.2.1 All information and data exchanged between the Contractor and the SWC shall be copied to the Engineer for information.
- 11.7.3 **Control of Sub-Contractors**

- 11.7.3.1 The Contractor shall be responsible for coordinating and controlling the interface activities of his sub-contractors with other SWC and their sub-contractors.

Integrated Testing and Commissioning with the Civil and System-Wide Contractors

- 11.7.3.2 Before the commencement of integrated testing, the Contractor shall complete the testing of the equipment / system that he has installed.
- 11.7.3.3 The Contractor shall coordinate with the SWC in preparing an integrated test plan to test all the points, equipment and systems. All testing equipment, instruments, tools and manpower required for the testing, which will be witnessed by the Engineer, shall be provided by the respective contractors.
- 11.7.3.4 Upon completion of testing, the respective SWC shall endorse the test records for submission to the Engineer. Where a failure is recorded in any test, the Contractor and the SWC shall re-schedule another test.
- 11.7.3.5 The Contractor shall be involved in the various integrated testing as indicated in the table below:

S/N	DESCRIPTION OF TESTS	LEAD CONTRACTOR	PARTICIPATING CONTRACTORS
Integrated Testing and Commissioning			
1	Station Smoke Test	T373B	T255, T278, T378B, Civil
2	ISCS with SWCs Point to Point and Functional Test	T255	T252, T253A, T256(TBA), T260, T271A, T271B, T273B, T275B, T278B, Civil, T373B, T375B, T378B
Test Running			
1	Tunnel Smoke Test	T373B	T251, T252, T255, Civil
2			

- i) Lead Contractors to arrange with the Civil Contractor/SWC for access to rooms.
- ii) The Test Running period is referenced in **Appendix B**. The Lead Contractor shall coordinate with the SWC to propose the Test Running programme subject to the acceptance of the Engineer.
- iii) The list indicated above is non-exhaustive and additional test will be added if it is deemed necessary by the Engineer. The Contractor shall carry out such additional tests at no additional cost to the Engineer.

11.7.4 Integrated Supervisory Control System (ISCS) Interface Requirements

11.7.4.1 The Contractor shall be responsible to ensure that the shutters installed under this Contract are fully interfaced and integrated.

11.7.4.2 The Contractor shall liaise and coordinate with the ISCS SWC to mutually agree the communication protocols to be used for all necessary data exchange. In addition, the Contractor shall interface with the ISCS SWC to sign off all interface control document and interface data document produce by the ISCS SWC.

11.7.4.3 The Contractor shall provide cables connecting and terminating from the shutters to the ISCS via the Interface Terminal Boards, ITBs (provided by ISCS SWC) for the control and/or monitoring of the shutters.

11.7.4.4 Interface Type

- a) Isolated voltage-free dry contacts rated at nominal 24V 1A dc each at the shutters control panels are for remote monitoring purposes. Each voltage-free contact shall correspond to a data point of and the shutters. The connections between shutters and ITBs shall be of twisted pair screen cables.
- b) Isolated contacts rated at nominal 48V, 1A dc each with resistive load at the shutters control panels are for each remote control purposes.

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