ANNEX G – ELECTRICAL SERVICES TECHNICAL SPECIFICATION

ELECTRICAL SERVICES

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1. LV CABLES

1.1 General

1.1.1 All main and sub-circuit cables shall be installed in conduits, trunking, trays and ladders as appropriate. All the mains, sub-mains and final sub-circuits shall include insulated earthing conductor sized in accordance with SS CP5. Earthing conductors shall be of flame retardant, low smoke zero halogen (LSOH) and anti-termite type.

1.1.2 The current carrying capacities and voltage drops of cables shall be in accordance with SS CP5, with ratings adjusted to suit local conditions.

1.1.3 The minimum size of cables shall be as specified herein, unless otherwise specified:

Small Power	:	2.5sq.mm
Control	:	1.5sq.mm

1.1.4 Normal and control cables shall be installed in separate cable containments.

1.2 600/1000 V AC Cables

1.2.1 All normal circuits cabling shall be of non-armoured flame retardant, LSOH and anti-termite type for underground stations. For elevated stations, cables shall be of flame retardant type.

1.2.2 All circuit cabling shall be armoured type where installed in the following:

(a) installed in troughs or trenches or underground pipes or ducts
(b) cable ladders
(c) exposed to weather elements

1.2.3 Cables exposed to weather elements shall be UV rated.

1.2.4 Fire resistant, LSOH materials shall meet the following requirements:

(a) IEC 61034 and BS EN 61034-2 – Measurement of Smoke Density of Cables burning under defined conditions.

(b) IEC 60331 and SS 299 – Tests for Electric Cables under fire conditions – circuit integrity.

(c) Limiting Oxygen Index of at least 30, to ASTM D-2863

(d) Temperature Index of 260°C, to ASTM D-2863

(e) All insulation is to be moisture and heat resistant, with temperature ratings appropriate to the application conditions and in no case lower than 90°C

(f) When a sample of cable is subject to the combustion test for the determination of the amount of halogen acid gases (other than hydrofluoric acid) as set out in IEC 60754-1 and the amount of halogen acid evolved is less than 5mg/g, the cable shall be regarded as zero halogen.

(g) BS 6387 and SS 299 Fire and Mechanical Test Categories C, W, Z

1.2.5 Steel wire armouring for the cabling shall comply with BS EN 10257-1 and the entire assembly shall meet the requirements of BS 5467.

1.2.6 Flame retardant, LSOH materials shall meet the requirements of items (a), (d), (e), (f) in Clause 1.2.4 together with the requirements of the following:

(a) IEC 60332 Tests on Electric and Optical Fibre Cables under fire conditions.

1.2.7 The above requirements shall be met without compromising the anti-termite (to comply with NEA regulations), mechanical and electrical properties of the cables, both during and after installation, to meet the other requirements of the specification.

1.2.8 Armoured cables shall be used for underground cables laying and comply with IEC 60502 while normal PVC/PVC is allowed for above-ground cable installation outside the station..

1.2.9 PVC cables shall not be permitted for the electrical installation within the station. All cables shall be 600/1000V grade. The conductor shall be of stranded conductor of plain annealed copper wire complying with IEC 60228 Class 2.

1.3 Colour Coding

1.3.1 The cable core colour code shall comply with the latest SS CP5 requirements.

1.3.2 The outer sheath of the cables shall be an extruded layer of either flame retardant or fire resistant material in accordance with Clause 1.2.4. The colour of the outer sheath shall be either black or other colour accepted by the Engineer.

1.4 Armoured Cable

1.4.1 All cables installed in the aboveground shall be insulated, wire armoured and rated at 600/1000V.

1.4.2 All multi-core armoured cables shall be single galvanised steel wire type. The armoured cables shall comply with BS 5467 for XLPE insulated type and BS 6724 for XLPE insulated with LSOH type. Single core armoured cables shall be of non-magnetic type.

1.4.3 Compression glands shall comply with BS 6121 and shall be designed for the termination and clamping of armour wires and shall be fitted with an earth bond terminal attachment. The function of the gland shall be to secure the armour wires and provide electrical continuity between the armour and the threaded fixing component of the gland, and to give water-tight seals between the cable outer sheath and the gland and between the inner sheath and threaded fixing components. The armour for cables shall not be used as earth conductor. All cable glands shall be complete with low smoke zero halogen cable shroud.

1.4.4 Where a watertight seal is required between the gland and equipment then the cable glands shall be equipped with entry thread seals. This is to maintain the IP rating across the equipment-gland interface, and such seals shall be fitted to the external side of the equipment. Earth tags/earth bond terminal connections shall not be fitted externally to the equipment if entry thread seals are used.

1.4.5 Jointing and terminating accessories shall include all necessary internal and external fittings and insulating materials. They shall also include precisely dimensioned cable stripping ferrules and the mechanical gland designs. It should be possible to erect and dismantle compression glands without the use of special tools.

1.4.6 All cables entering or leaving equipment shall be provided with separate termination and be spaced so that any one cable out of a number of such cables can be removed without disturbing the rest.

1.4.7 Cable armour shall be earthed at both ends of cable circuit.

1.5 Control and Sensing Cables

1.5.1 Control and sensing cables, operating on less than 230 V AC supply shall be of minimum rated at 300/500V grade, copper conductor, twisted pair, insulated and sheathed with a flame retardant, LSOH material. Fire resistant

cables shall be used for critical circuits. 600/1000V cables shall be used for control cables operating on 230 V AC supply.

All control and sensing cable shall be appropriately colour coded and shall be installed in its own cable support system (E.g. conduit, tray, trunking etc). Sharing with power and lighting cable support system is not allowed.

1.6 Cable Installation

1.6.1 The requirements for cable brackets shall be submitted and to ensure the design is endorsed by Professional Engineer.

1.6.2 Power cables and control cables shall be run in separate cable ladder / trays / trunkings.

1.6.3 Cables shall be terminated using suitably crimped cable lugs and brass glands with rubber gasket.

1.6.4 A flame retardant LSOH shroud shall be fitted to cover the cable lug.

1.6.5 All cables shall be adequately protected against risk of mechanical damage to which they may be liable in normal condition of service.

1.6.6 All cables shall be installed in accordance with SS CP5.

1.6.7 Where single-core cables are used for 3-phase circuits, the cables shall be grouped in trefoil and spaced from other cables.

1.6.8 Where cable pass through fire-rated floors and walls, the openings made shall be sealed with fire-resistant material of fire rating equal to or higher than the fire rating of the floors or walls.

1.6.9 All cables installed on cable trays and ladders shall be properly fixed by halogen free, epoxy coated heavy duty stainless steel cable ties for indoor and outdoor areas. All cable ties shall be corrosion free.

1.6.10 Where cables pass through expansion joints, the cables shall be formed into loop that shall be of such size that any movement in the joint shall not stress the cables.

1.6.11 All cables installed at low level up to 1.5 meters from the finished floor level shall be adequately protected by perforated cable tray.

1.6.12 All cables shall be concealed behind architectural finishes and the cable routing shall be properly co-ordinated for any recesses, openings etc. They

shall be run neatly and vertically, horizontally or match the features of the building.

1.6.13 All cables runs shall be continuous and without joints unless otherwise accepted by the Engineer. Any unauthorised and undeclared joint and splices will be rejected and the Contractor shall replace the full length of cable run.

1.6.14 Where cable joints have been accepted by the Engineer, only approved connections in accessible junction boxes where joints are specifically approved by the Engineer shall be used for cable jointing. Every connection at a cable joint shall be mechanically and electrically sound, be protected against mechanical damage and any vibration liable to occur, shall not impose any appreciable mechanical strain on the fixings of the connection and shall not cause any mechanical damage to the cable conductors. Joints shall be appropriate to the size and type of cables which they are used. The appropriate tools specified by the manufacturers of the joint connectors shall be used. Cable cleats shall be of the moulded reinforced nylon type.

1.6.15 Cable Identification

(a) All cables shall be provided with identification markers for identification of circuit number and phase, at each end of the cable, at entry and exit points of cable installed in ducts and in such other position as are necessary to identify and trace the route of any cable.

(b) Cable identification shall be assembled from elliptical profiled LSOH markers, carrier strips and nylon ties.

(c) Every single core cable and every core of multi-core cables shall be provided with identification at its termination in form of tapes sleeves or discs of appropriate colours and alpha numeric notation in accordance with the latest revision of SS CP5.

1.6.16 Cables Installed Underground

(a) All underground cables shall be drawn in appropriate pipes. Concrete encasement around pipes containing the underground cables shall be provided for protection purpose. Cables passing under roadway shall be minimum 1000mm deep. The depths may be varied in certain circumstances due to the proximity of cables or other services.

(b) Non-armoured single core power cables shall be physically protected from damage.

(c) Armoured cables buried in open ground shall have a layer of cable tiles or similar approved material laid above the buried cable. Cable tiles shall be of the cast type and be marked 'Electrical Cable'. Alternatively, PVC marker type may be used.

(d) Cable route markers shall be installed at changes of direction and at 1500mm intervals on straight runs of cables.

(e) Cables shall be installed without tees or through joints unless otherwise accepted by the Engineer.

(f) Where cables are laid in concrete troughs and cable drawpits, the troughs and cable drawpits shall be filled with suitable sieved sand.

2. CABLE SUPPORT SYSTEM

2.1 General

2.1.1 All cable support and accessories shall be made of hot-dip galvanized steel in accordance with the relevant Clauses of BS EN ISO 1461. Standard proprietary fittings shall be used. All drilling, punching, cutting, bending and removal of burrs shall be completed before galvanising and any surfaces that have been scratched, marred or otherwise damaged shall be made good with a comparable zinc coating.

2.1.2 Clamps shall be used when installing on finished metal structure where drilling is not allowed by the Engineer. The Contractor shall coordinate the support mounting method with Civil Contractor prior to the work.

2.1.3 Where equipments or cable containments are specified to be installed in between the span of mountable structural element, the Contractor shall provide the secondary support framing at no additional cost to the Authority for fixing the equipment correctly to the specified position.

2.1.4 All non-sheathed electrical cables shall be installed in screwed heavy gauge welded steel conduit (surface or embedded) or trunking. All cable containment shall be of adequate size (including 20% spare capacity) and lengths for the cabling system.

2.1.5 All normal, essential and control cables shall be installed in separate containment. Where cables are installed in lay-in troughs and trenches, concrete dividers shall be provided by the Contractor along the entire length. Where cables are installed in trenches and service corridors with brackets and/or cable trays, separate bracket/tray shall be provided.

2.1.6 Whenever conduits, cable ladders, cable brackets, cable trays or trunkings pass through an opening, the Contractor shall be responsible for sealing the gaps between wall/floor and conduits, cable ladders, cable trays or trunkings and within trunking with sealing material having the same fire-rating as the wall or floor.

2.1.7 All conduits, cable ladders, cable brackets, cable trays and trunkings shall be orange in colour except those for telephone distribution shall be in white colour. The word 'ELECT-N' (for normal circuit), 'ELECT-E' (for essential circuit), 'CTR' (for control), 'TEL' (for telephone distribution) in black shall be marked on the underside of the cable trunking / tray. The spacing between markings shall not exceed an interval of 3m. The method of labelling shall be submitted for the Engineer's acceptance.

2.1.8 All electrical services support / bracketries shall be deemed included for completion of installation.

2.1.9 Manufacturer's purpose-made accessories (e.g. bends, corners, intersections, tees, risers, reducing section etc.) shall be used.

2.2 Cable Trunking

2.2.1 All trunking shall comply to SS 249 and be constructed of zinc coated mild steel sheets, finished with one coat etching primer and powder epoxy coating. Hot-dip galvanised trunking shall be used for installation outdoor and in wet areas. Trunking shall be fitted with removable covers of the same material, extending over the entire length.

2.2.2 Trunking supplied shall be complete with purpose made connectors, dividers, flanges and retaining clips including cable pin tacks to avoid strain on cables on extended vertical runs. Earth continuity copper links shall be supplied in accordance with manufacturer's recommendations. Vertical trunking shall be provided with suspension units and thrust blocks.

2.2.3 Trunking shall be fixed rigidly to walls and ceilings at not more than 1000 mm centres. Approved metal expansion anchors shall be used for fixing to walls and wooden or fibre plugs shall not be used for this purpose. The type and position of the screw heads within the cable carrying compartment shall be selected to minimise the likelihood of damage to cables during installation.

2.2.4 All lid fastening components shall be captive and arranged such that lids can be easily be removed without damage to cables. When fastened, the lid shall be securely held tight to the trunking body along the whole length.

2.2.5 Suspended trunking shall be supported at not more than 1000mm centres.

2.2.6 The type and position of screw heads within the cable carrying compartment shall be selected so as to minimise the likelihood of damage to cables during installation or operation.

2.2.7 All lid fastening components shall be captive and arranged such that lids can easily be removed without damage to cables. When fastened the lid shall be securely held tight to the trunking body along the whole length.

2.3 Underfloor Trunking

2.3.1 Underfloor trunking shall be manufactured to BS 4678 from 1.6mm zinc-coated steel with base plate and body welded together into a single unit with compartments.

2.3.2 The Contractor shall coordinate with Civil Contractor to provide the proper type of underfloor trunking in screed floor and/or raised floor. The screed thickness and raised floor void height shall be coordinated with Civil Contractor based on the recommendation from the selected supplier.

2.3.3 All trunking bend units shall have a minimum bending radius of 75mm.

2.3.4 Inspection boxes shall be fabricated from sheet steel with adjustable frames and trays and galvanised after manufacture. Recessed trays shall be provided with the recess suitable for the floor in fill. Conduit connection points and crossovers shall incorporate inspection access.

2.3.5 The trunking shall be fixed to the sub-floor by means of mild steel fixing saddles complete with levelling screws and shall be properly packed with screed to ensure that no voids exit to allow trunking to collapse when any weight is applied to the surface.

2.3.6 Prior to floor screeding and finishing, all outlets shall be provided with standard tapered wood plugs of suitable length and easy removal after floor finishing. The trunking shall be suitable for drilling, tapping and installing further pedestal outlets after floor finishing.

2.3.7 The underfloor trunking system shall be 3 compartments with each compartment completely separated. Each compartment shall be properly labelled at each access point.

2.4 Cable Trays

2.4.1 Cable trays shall be of the perforated, heavy duty return flange type and manufactured to IEC 61537 or BS EN 61537 and accessories to BS EN ISO

1461 and shall be constructed of perforated mild steel, electro-galvanised with an epoxy powder coating. The minimum thickness for cable tray up to 450mm wide shall be 1.5mm, for widths above this 2mm sheet shall be used. Hot-dip galvanised cable trays shall be used for installation in outdoor and wet areas.

2.4.2 All cable tray shall incorporate a return flange 10mm high for widths up to 250mm and 20mm above this value. Bends and tees shall be identical in construction material and profile to straight runs and all bends shall incorporate gusseting to standard radii.

2.4.3 Cable tray shall be supported at intervals by galvanised steel hangers fixed to walls or ceilings as applicable at maximum of 1000mm centres and 300mm on bends and at tees. Earth continuity copper links and tray connections shall be installed in accordance with the manufacturer's recommendations.

2.4.4 Standard proprietary fittings shall be used.

2.4.5 Cable trays shall be cut along a line of plain metal (i.e. not through perforations) only. All cut edges shall be cleared of sharp edges and burrs and treated with zinc-coated paint to ensure continuous protection.

2.4.6 Earth continuity copper links and tray connections shall be installed in accordance with the manufacturer's recommendations.

2.5 Cable Ladders

2.5.1 Cable ladders shall be heavy duty flange type and manufactured to IEC 61537 and accessories to BS EN ISO 1461 and shall be constructed of perforated mild steel, electro-galvanised with an epoxy powder coating. The minimum thickness for cable ladder shall be 2.0mm. Hot-dip galvanised cable ladder shall be used for installation cable ladder shall be used for installation in outdoor and wet areas.

2.5.2 The cable ladder side channels shall be strengthened by reinforcing inserts to increase the torsional rigidity.

2.5.3 The cable ladder shall be complete with rung slots of 50mm width and of minimum thickness of 2.0mm spaced at maximum 300mm at the straight run.

2.6 Conduits and Fixings

2.6.1 Conduits and fixings shall be manufactured in accordance with BS EN 61386-1 and IEC 61386-23. The minimum nominal bore diameter of conduits shall be 25 mm. Conduits shall be of heavy gauge hot-dip galvanized welded steel,

screwed and longitudinally welded and protected against corrosion to IEC 61386-1 and BS EN 61386-1 Class 4. Conduits shall have threaded ends and conduits embedded in concrete shall have the threads coated with jointing compound during assembly. Care shall be exercised to ensure that the conduit and boxes are water-tight before concrete is poured, this may include the use of metal caps or plugs to prevent water or entering the open ends. All conduit fittings shall be hot-dip galvanised or of corrosion resisting materials.

2.6.2 The ends of all conduits shall be reamed to remove all burrs and sharp edges after screw threads have been cut. The exterior shall be made free of all dirt, oil and grease and the interior swabbed through before the installation of cables. All exposed threads and bends shall be given a coat of zinc rich paint after installation. All conduits termination should be non-swivel type.

2.6.3 The ends of all conduits shall be installed solidly in all couplings. Where conduits terminate in fuse switches, distribution boards, adaptable boxes or similar accessories, they shall be connected by means of smooth bore male bushes, compression washers and sockets. The integrity of the protection rating of the equipment or accessory shall not be reduced as a result of the conduit connection. Final connections to motors or other equipment subject to movement or vibration shall be made with short lengths of appropriately sized flexible steel conduits with appropriate adapters. All free ends of conduits shall be fitted with a smooth bore male brass bushing.

2.6.4 Each run of conduit shall be assembled with draw-wires. Long radius bends shall be used although not more than two right angle bends shall be installed without the interposition of a draw box. Full size junction boxes and not box type tees, elbows, or fittings shall be used to facilitate the drawing in of cables and the possible subsequent removal and replacement of any one cable or group of cables without disturbing the rest. Draw boxes shall be installed such that the maximum run length between draw points is 10 m.

2.6.5 Conduits shall run parallel to walls, floors and ceiling wherever possible. Multiple conduit draw-in boxes shall be used wherever a number of conduits follow the same route. All conduit fixings and boxes shall be screwed to or on walls and ceiling independently of the conduit.

2.6.6 Approved metal expansion anchors shall be used for fixing to walls and wooden or fibre plugs shall not be used for this purpose. Fixing holes in boxes shall be adequately countersunk to ensure that screw heads do not protrude into the wireways.

2.6.7 For embedded conduit runs, deep boxes or extension rings on standard boxes shall be used to ensure that the front of each box finishes flush with the surface of the wall or ceiling. All junction and pull boxes shall be installed so that covers are readily accessible and removable after completion of the

installation. Boxes shall not be installed above suspended ceilings, except where the ceiling is of the removable type and definite provisions are made for access at a point close to each box.

2.6.8 Conduit back boxes shall be provided where conduits turn through walls. Conduits crossing expansion and contraction joints shall be provided with a short-length of flexible metal conduit, sufficient to allow for a movement of 10 mm.

2.6.9 Conduits shall be fixed by means of hot-dip galvanised saddles at maximum 1000 mm centres on vertical runs and maximum 750 mm centres on horizontal runs. All conduits shall be fixed by full saddles at a maximum of 300 mm each side of a bend and vertical conduit runs shall have saddles within 300 mm from their points of emergence from floors or ceilings.

2.6.10 Conduits in ceiling cavities shall be supported independently of the suspended ceiling fixings. Concealed conduits chased into surfaces shall be secured such that the fixings alone hold the conduits in place. Recesses in plaster shall be deep enough to permit a full 6 mm cover over the entire run of the conduit.

2.6.11 The ingress protection of the boxes and fittings shall be appropriate for the environment in which the conduit shall be installed. Where appropriate, provision for tapping of condensed moisture shall be made. Watertight cast iron boxes shall be used in wet or damp locations. Outlet, junction and pull boxes for use inside the building shall be zinc-coated.

2.6.12 LSOH flexible conduits and fittings shall comply with IEC 61386-23. The flexible conduit adapter shall be of watertight, metallic and nickel plated and shall be secured to the flexible conduit via an internal threaded appendage to ensure that the sharp edges of the flexible conduit are not in direct contact with the cables.

2.6.13 All conduits and fittings for installation in wet areas shall be of non-metallic, flame retardant low smoke zero halogen material.

2.7 Cable Bracket

2.7.1 Cable brackets shall be hot-dip galvanized in accordance with BS EN ISO 1461 and sheradised bolts, spring washer, nuts to grade SS316 shall be used.

2.7.2 Cable brackets shall be freed from sharp edges before hot dip galvanising.

2.7.3 Cable brackets shall be properly spaced at distance not exceeding 1000 mm for straight run to satisfactorily support the weight of the cables. They shall also be provided at a distance not exceeding 300 mm on every side from a

bend or intersection. Epoxy coated heavy duty stainless steel cable ties for indoor and outdoor area. All cable ties shall be corrosion free.

2.7.4 Cable bracket shall be of adequate mechanical strength, securely fixed to the walls, ceiling or other structure.

2.7.5 Cable bracket shall be provided with sufficient fixing facilities such that the cables and cable trunking can be securely fixed on cable bracket.

3. ELECTRICAL FITTINGS & ACCESSORIES

3.1 General

3.1.1 Electro-galvanised with an epoxy powder coating boxes shall be used as junction boxes (IP65), pull boxes or terminal boxes in exposed or embedded conduit runs in the stations. Stainless steel boxes (IP65) shall be used for installation in outdoor and wet areas. The boxes used shall be sized to code requirements. Boxes shall be provided where surface mounted cables interface with embedded conduits for proper termination of cable and cable fittings. Outlet, junction and pull boxes for use inside the stations shall be zinc-coated.

3.1.2 All switched socket outlets shall be labelled by an approved means to identify the circuit number and the source of supply to which they are connected.

3.2 Switched Socket Outlets

3.2.1 Switched socket outlets shall be single pole (13A) metal-clad or matt-chrome, 3 rectangular pin switch shuttered outlets, either surface or flush mounting according to location. All switched socket outlets shall be listed under the Product Listing Scheme and tested by a recognised testing body.

3.2.2 Switches shall be of the quick make, slow break type with silent, totally enclosed switch action and solid silver alloy contacts. Switched socket outlets for indoor use shall be housed in suitable galvanised steel boxes to BS 4662 with conduit knockouts.

3.2.3 Switched socket outlets located in exposed and wet areas shall be of weatherproof type to IP65. Earth terminal shall be provided inside the socket outlet. Switched socket outlet located at the entrance area and station public areas shall be complete with padlockable cover plate.

3.2.4 Generally switched socket outlets shall be positioned at 300mm above finished floor level to the bottom of the mounting boxes except in plantrooms, service corridors, and pantry etc. where they shall be positioned 1200mm

above finished floor level to the bottom of the mounting boxes or minimum 150mm above counters or benches whichever is suitable.

3.2.5 The actual positions of the outlets shall be determined on Site. Any shifting of outlets from the indicated positions shall not incur any extra cost to the Authority.

4. EARTHING SYSTEM

4.1 General

4.1.1 The Contractor shall provide all the electrical earthing system including all the equipotential bonding and associated containment system.

4.1.2 All metal conduits, trunking and tray systems, supports, cabinets, equipment cases, cables screen and armour, electrical fittings and fixed appliances liable to become live in the event of insulation failure, shall be effectively earthed by means of earth continuity conductors of adequate size. The entire earthing installation shall fully comply with the requirements of SS CP5 and SS 551.

4.1.3 The earthing continuity conductor shall be of high conductivity copper and continuous throughout its length without joints except by exothermic conductors.

4.2 Earthing Connections

4.2.1 Earth continuity conductors from all exposed metal parts of equipment required to be earthed including earth connections to plug sockets shall be connected by one of the following appropriate methods:

(a) To earth connection at the distribution board supplying the equipment on plug socket.

(b) To any point on the sub-main or main earth continuity conductors supplying the relevant equipment.

(c) To residual current circuit breaker where installed.

4.2.2 The contact faces of protection conductors at earth bars shall be cleaned and tinned before any connections are made.

4.3 Labels

4.3.1 Both ends of the earth cable shall be labelled. The labels shall indicate the origin and the destination of the earth cable.