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## SECTION TS 27. ELECTRICAL WORKS

### 27.1 GENERAL REQUIREMENTS

#### 27.1.1 General

This section covers the general and specific requirements for electrical works for the Simongan Weir Reconstruction and shall apply to all electrical works to be performed under the Contract, including all electrical works for the weir gates, intake gates and ancillary systems referred to in Section TS 26.

Design requirements for gate operation systems are specified in section TS 26 which shall be read in conjunction with this section.

Unless otherwise specified, electrical works for Building Works, as defined in Clause 28.2 of TS 28, shall comply with the technical specification for electrical works appended to section TS 28.

#### 27.1.2 Scope Work

- 1) The work includes the supply of materials, workmanship, fabrication installation, erection, testing and commissioning of all Electrical Works under this Contract.
- 2) Supply and installation for the following major items are included.
  - a) Exterior electrical works, service entrance, duct banks, handholes and feeder cables
  - b) Exterior lighting
  - c) Grounding and lightning protection
  - d) Electrical test
- 3) "General Requirements" shall apply to the following major items.
  - a) Generator Control Panel
  - b) Remote Control Panel
  - c) Switchboard
  - d) Flushing Gate Control Panels
  - e) Main Flood Diversion Gate Local Control Panels
  - f) Intake Gate Control Panels
  - g) Power cable/power supply to all plant ancillary motors/equipment
  - h) Control and alarm cables for the whole plant

#### 27.1.3 Applicable Standards and Regulations

The following standards shall be applied to the design and manufacture of the electrical equipment and fittings:

National Electrical Code	(NEC)
National Fire Protection Administration	(NFPA)
Applicable Regulation and Standard	
National Electrical Manufacturer's Association	(NEMA)
Underwriters' Laboratories	(UL)
Illuminating Engineering Society	(IES)
Japan Industrial Standards	(JIS)
Institute of Electronics and Electrical Engineers	(IEEE)
International Electrotechnical Commission	(IEC)

#### **27.1.4 Qualifications**

- 1) For Contractors or Subcontractors of Electrical Equipment and Materials:
  - a) Company regularly providing type of works required for not less than 20 years before the date of submission of Bid.
  - b) Retain full responsibility for all requirements under Section 27.1 herein; and including all necessary co-ordination of work with manufacturers.
  - c) Workmen shall be well trained and experienced in type of works required.
- 2) For manufacturers of Equipment and/or Systems:
  - a) Regularly producing or systems of types required for not less than 20 years before the date of submission of Bid.
  - b) Retain full responsibility for all requirements of particularly equipment or system where specifically so specified under respective Technical Sections.
  - c) Capable of providing immediate emergency service within three (3) days after notification by Employer.
  - d) Capable of entering into full service maintenance agreement with Employer after the date of issuance of Defect Liability Certificate.
  - e) Requirements herein substantiated by sufficiently complete documentation accompanying Bid's Proposal.
  - f) Workmen shall be well trained and experienced in type of works required and in direct employ of the manufacturer.

#### **27.1.5 Codes, Inspections, Permits and Fees**

The works under this Contract is to be installed according to the requirements of the latest Indonesian Electrical Code, and the applicable ordinance and requirements of the local power company. Nothing contained in these Specifications or shown in the Drawings shall be construed as to conflict with National and Local Ordinances or Laws governing the installation of electrical works, and all such laws and ordinances are hereby made part of these Specifications. The Contractor is required to meet the requirements thereof.

All permits and electrical fees required for this works shall be obtained by and at the expense of the Contractor. The Contractor shall furnish the Engineer and the Employer final certificates of inspection and approval from the proper government authorities after the completion of the Works. The Contractor shall prepare all as-built drawings and all other paperwork required by the approving authorities.

#### **27.1.6 Guarantee**

The Contractor shall guarantee that the electrical system is free from all grounds from all defective workmanship and materials and will remain so for a period of one year from the date of issuance of Certificate of Completion of the Works. Any defects, appearing within the aforesaid period, shall be remedied by the Contractor at his own expense.

The Contractor shall indemnify and save harmless the Employer and the Engineer from and against all liability for damages arising from injuries or disabilities to persons or damage to property occasioned by any act or omissions of the Contractor or any of his Subcontractors, including any and all expense, legal or otherwise which may be incurred by the Employer or the Engineer, in the defence of any claim, action or suit.

### **27.1.7 Record Drawings**

The Contractor shall, during the progress of the works, keep a careful record of all changes where the actual installation differs from that shown on the Contract Drawings. Upon completion, the Engineer will furnish at no cost a complete set of prints on which the Contractor shall in a neat and accurate manner make a complete record, as installed in the completed works. This drawings will be the basis for the preparations of "as-built" drawings.

### **27.1.8 Shop Drawings and Samples**

Further to the requirements of clauses GS 1.4 and GS 1.5 within 60 days of receiving the Letter of Acceptance, prior to the manufacture of the plant and prior to any installation works, the Contractor shall prepare and submit for approval shop drawings and cuts of all equipment, appliances and fixtures to be furnished. After final approval by the Engineer, the Contractor shall submit three (3) copies to the Engineer. Fixture and devices cuts and/or catalogues shall be clearly marked to indicate the items furnished.

The Contractor shall submit to the Engineer for his approval samples of conduit, wire, wiring devices, finished plates and of any other items as may be requested by the Engineer.

### **27.1.9 Approvals and Substitutions**

Wherever hereinafter the words "for approval", or "approved" (make, type, size, arrangement, etc.) are used, especially with regard to manufactured specialities, etc., or wherever it is desired to substitute a different make or type of apparatus for the one specified, all information pertinent to the adequacy and adaptability of the proposed apparatus, shall be submitted to the Engineer for approval but based on the Drawing details. All location for the electrical equipment shall be subject to the approval of the Engineer.

### **27.1.10 Subcontractors**

The Contractor shall be held fully responsible for the works of any Subcontractors performing works for or manufacturers supplying materials, as it is intended that the Electrical Works, when finally delivered to the Employer shall be ready in every respect for satisfactory and efficient operation.

### **27.1.11 Workmanship**

The work throughout shall be executed in the best and most through manner under the direction of and to the satisfaction of the Engineer, who will interpret the meaning of the Drawings and Specifications and shall have power to reject any work and materials which in his judgement are not in full accordance with the Drawings and/or Specifications.

### **27.1.12 As-Built Drawings**

The Contractor shall have, on file for ready access and reference, a set of drawings indicating all works as actually installed incorporating in the same all changes and additions. Upon the Acceptance of the Contract, he shall prepare and submit a set of as-built drawings indicating thereon the Electrical Works as actually and finally installed.

### **27.1.13 Standards of Materials**

All materials shall be brand-new and shall conform with the standards of Underwriters; Laboratories, Inc. IEEE, NEMA and ASTM for every case where such standard has been established for the particular type of material in question.

All materials on all systems shall comply with the Specifications, unless specially excepted and all materials where not specified shall be of the best of their respective kind.

Details of specified materials shown on the Drawing shall be submitted for approval as required by the Engineer.

### **27.1.14 Approval of Materials**

All electrical materials shall be new and shall meet the requirements and shall bear the inspection label wherever standards have been established. Within thirty (30) days after the issuance of Notice to Commence, and before any materials or equipment are ordered, the Contractor shall submit to the Engineer for his approval, a complete list of materials, apparatus and equipment, in triplicate, giving the manufacturer's name, address, descriptive data, trade name of item, rated capacities, certified analysis, catalogue numbers, etc., and when called upon to do so, complete specifications and cut or drawing of each item, of whole or portion of list, as required by the Engineer, which he proposed to use or install.

### **27.1.15 Ground Test**

The entire installation shall be free from improper grounds and from short circuits. Tests shall be made in the presence of the Engineer. Each panel shall be tested with mains connected to the feeder branches, and switches closed, all fixtures in place and permanently connected, lamps removed or omitted from the sockets and all wall switches closed. Each individual power feeder shall be tested with the power equipment connected for proper and intended operation. In no case shall the resistance be less than that allowed by the Regulations for Electrical Equipment of Buildings. Failure shall be corrected in a manner satisfactory to the Engineer.

### **27.1.16 Performance Test**

It shall be the responsibility of the Contractor to test all systems of the entire electrical installation for proper operational conditions. These conditions shall apply to the power and lighting installation as well as low voltage and alarm, control, and signal systems. Where sequence operation is required, the Contractor shall test for proper sequence for the entire electrical installation and for satisfactory working condition as approved by the Engineer.

### **27.1.17 Related Documents**

- 1) General: Materials and equipment shall not be ordered or fabricated until submittals have been approved.
- 2) Construction/Shop Drawings: complete as specified, as applicable to Sections under these Specifications, and to indicate:
  - a) Complete dimensional data.
  - b) Elevation views for complete representation.
  - c) Construction details for anchorages to structures.
  - d) Arrangement of devices and appurtenances.

- e) Waterproofing details for exterior and underground works and penetrations.
  - f) Location and size of connections.
  - g) Identification schedules.
  - h) Substituted equipment or materials requiring changes in sizes, connections, arrangements, installations or wiring.
  - i) Wiring diagrams as specified elsewhere herein for work and systems as proposed.
  - j) Manufacturer's certified drawings for all major equipment items.
  - k) Detail wiring plans for all electrical systems.
- 3) Material/Colour Samples: Provide for primary materials or finishes or other components and when requested by the Engineer.
  - 4) Certification of Materials: from equipment or system manufacturers; or from independent testing or agencies employed by them, indicating compliance with requirements specified herein for various items of equipment and system.

#### **27.1.18 Supervision of Electrical Works**

- 1) General Electrical Works: Contractor shall furnish full-time services of one or more experienced professional electrical engineer well qualified in directing and overseeing all phases of works of type required.
- 2) Electrical Equipment: Contractor shall furnish services of manufacturer's specialised engineer in full time as necessary to supervise equipment installation and for the execution of testing and commissioning for the said supplied.
- 3) Supervisory Personnel: Maintain at premises of works for as long as necessary to continuously supervise all of various phases of Works required, including installations, erection, testing, commissioning, start-up adjusting and initial operations, and for instruction of Employer's operating personnel.
- 4) Retaining or arranging for manufacturer's representative shall not be construed as waiver of responsibilities of the Contractor for works as required herein.

#### **27.1.19 Product Requirements**

- 1) Electrical Materials, Assemblies and System unless or except as shown, specified or approved shall conform to the followings:
  - a) Manufacturer's first quality line of standard and/or series or factory fabricated items as shown or specified.
  - b) Comparable materials, assemblies and system of manufacturers other than as specified may be proposed where differing in minor details only and otherwise comply with requirements shown or specified subject to prior approval by the Engineer.
  - c) Materials and equipment shown or specified shall be essentially standard catalogue products or approved manufacturers and variations there from shall be only as specified or approved by the Engineer.
  - d) Where two or more units of same class, type or kind are required, units shall be products of a single manufacturer. However, component parts of a system need not be products of the same manufacturer.

- e) Where a device, part or piece of equipment is referred to in singular number, such reference shall apply to all services or parts required to complete the works.
- f) Electrical parts and components identical throughout each electrical system shall be readily interchangeable.

#### **27.1.20 Equipment Work Requirements**

- 1) Equipment shall be especially designed for particular use, function or operation intended; and items of the same kind shall be designed, fabricated and supplied by a single manufacturer for all works under this Contract.
- 2) Each system of equipment shall be designed, fabricated, and furnished by a single manufacturer.
- 3) Equipment, materials and appurtenances specified shall be new, and shall be installed as indicated; shall conform to respective specifications and requirements as specified or approved; and shall be installed complete, tested and made ready for services intended.
- 4) Products for Works under this Contract shall be designed, fabricated and constructed for the purpose and use intended; and in accordance with or capable of meeting standards for Electrical Works as specified herein or under other Technical Sections as approved by the Engineer.
- 5) Compliance shall be substantiated by sufficient and adequate prototype testing or otherwise evidenced by such operational reports and data as may be required by the Engineer to fully demonstrate performance characteristics, operational qualities, reliability, safety and other relevant considerations.

#### **27.1.21 Execution Requirements**

- 1) Prior to starting works:
  - a) Review provisions of the General Specification for requirement affecting this Works.
  - b) Review details of Works with the Engineer, incorporating adjustments deemed necessary and as directed.
  - c) For interior works, building shall be adequately closed and/or protected.
  - d) For installation of equipment or other sensitive equipment or components, building shall be entirely enclosed and fully protected; and specific interior protection arranged for and installed.
- 2) Works shall not proceed until Contractor has verified the following:
  - a) Supporting construction to be in proper condition and any improper construction conditions have been corrected, re-inspected and approved by the Engineer.
  - b) Layouts, locations and tolerances are correct for this Work.
  - c) Respective areas receiving electrical works have been inspected by the Engineer.

## **27.1.22 Completion Requirements**

### **1) General:**

- a) Remove waste and debris resulting from this works; as work progresses and upon completion.
- b) Service and adjust moving or mechanical parts for smooth, quiet and proper operating condition.
- c) Touch-up abraded or damaged prime painting or galvanizing and leave clean and ready for finishing Works required.

### **2) When Completed:**

- a) Exposed surfaces shall be clean and free from dust, dirt, scratches, dents, broken parts, misaligned or improperly fitted joints, stains, discoloration or other defects or damages.
- b) Installation shall be free from exposed fastening, unnecessary cuts, holes, blank plates, advertising labels or signs; other than as particularly specified or approved.
- c) Each hole and all openings required for the pulling of wire inside cable pit shall be sealed off after the works for possible entry of insects and foreign materials.
- d) Exterior or below grade installation shall be watertight throughout and free from leaks or entry of water into or through interior or concealed spaces of structures.
- e) Each item, unit or assembly shall be tightly and rigidly secured in place free from unnecessary movement, squeak or rattle.
- f) Each item, unit or assembly shall be set straight, plumb and level; accurately positioned at locations required; adjacent similar units accurately aligned.
- g) Movable mechanical items or devices shall be serviced and adjusted to operate smoothly, quietly, easily and free from binding or superfluous or unwanted noise.
- h) Mechanical assemblies or system shall be serviced and adjusted to operate in compliance with performance requirements shown or specified; and tested as specified.
- i) Electrical devices, assemblies or systems shall be properly connected and grounded, operating in compliance with performance requirements shown or specified, and tested as specified.

## **27.1.23 Servicing Requirements**

### **1) Lubrication:**

- a) Lubrication facilities shall be incorporated for all parts involving friction and wear; other than where suitably covered or protected by resilient materials; or provided with life-time packing or fittings, at no extra cost.
- b) Include all necessary grease fittings, oiling caps or other like facilities as required to maintain equipment properly protected; and with all similar items essentially identical and serviceable using same lubrication tools throughout.
- c) Locate lubrication facilities where readily visible and positioned where easily accessible.

## 2) Service Tools:

- a) Two complete sets as required for each equipment, item or system or work.
- b) Comprising all necessary lubricating tools and supplies; and any specialised hand tools necessary for operation, adjustments or regular up-keep service which are of types usually carried or readily available.
- c) Each set contained in suitable metal box or panel; outside of container shall clearly identified the respective equipment for which required.

### 27.1.24 Maintenance Services

- 1) Contractor shall furnish maintenance and call-back service for all electrical systems after completion and placed in operation; for duration of Defect Liability period required under this Contract.
- 2) These services shall consist of examinations of equipment, adjustments. Lubrication, cleaning, supplies and parts to keep the equipment in proper operation; and for wherever reason or cause.
- 3) When such adjustments, parts or repairs are made necessary by abuse, misuse or other cause beyond control of Contractor, or manufacturer, same shall be provided except that an additional reasonable cost shall be paid by Employer.
- 4) All works will be done by trained employees of the Contractor or manufacturer during regular working hours of the trade.
- 5) Emergency services shall be available when called for, at additional cost to Employer except where cause are attributable to Contractor or manufacturer.

### 27.1.25 Certification of Installation

- 1) Required for all general equipment work and systems.
- 2) Prepared by Contractor or by independent testing agencies regularly providing test and inspection type works required and as retained by the Contractor.

### 27.1.26 Maintenance Instructions

- 1) Required for each of various electrical systems.
- 2) Include manufacturer's recommendations for daily / weekly / monthly maintenance or up-keep which should be performed by the Employer between times of manufacturer's service maintenance calls.

### 27.1.27 Operating Instructions

- 1) For general use and operation of various equipment and systems.
- 2) Each set of instructions specifically prepared for equipment or systems as installed.

### 27.1.28 Service Manuals

- 1) Basic Service Manuals : Provide as part of initial submittals including :
  - a) Complete list of spare parts and current price lists thereof.

- b) List of especially critical parts recommended by manufacturer which should be maintained by Employer at Project locale, including price lists thereof.
- 2) Complete Service Manuals : Provide as specified; prior to completion of work :
  - a) All data as required for Basic Service Manuals.
  - b) Other data as may be particularly required under various Technical Sections.
  - c) Wiring diagrams for Works as installed.
  - d) Complete Equipment Identification Schedule for Work as installed.

### 27.1.29 Project Identification Signs

- 1) Required for each electrical equipment item; in readily visible locations; each sign installed level and symmetrically positioned.

#### 2) Sign Description:

- a) Size :Suitable for size of equipment upon which sign is mounted.
- b) Type :Laminate bakelite with engraved letters or other standard with equipment manufacturer as approved by the Engineer.
- c) Colours :Black plaque, white letters, unless otherwise directed or approved by the Engineer.
- d) Letters :Plain block or gothic style only.

#### 3) Designation

- a) Named acrylic resin plates shall be posted at the upper part on front surface of all panelboards such as distribution boards equipped with circuit breakers, relays, fuses, etc., lighting panels, motor control panels and terminal boards for grounding and communication wiring.
- b) Named acrylic or metal plates shall be posted near meters, relays, switches on front surfaces of all panelboards.
- c) Pilot lamps and indication lamps on front surface of all panelboards shall be etched and imprinted.
- d) Name acrylic resin plates shall be posted on circuit breakers, relays, connection terminals and other parts in all panelboards.
- e) Identify individually:
  - 1) Each control panel
  - 2) Each switchboard
  - 3) Each disconnect switch or circuit breaker regardless if whether separately mounted or grouped with others in a single housing.
  - 4) Each wire or cable in each secondary feeder
- f) Each wire or cable in a feeder and control shall be identified at its terminal points of connection and in each pullbox, junction box, wireway, cable rack, cable trench and panel gutter through which it passes.
- g) The nomenclature used to identify switchboards and panelboards shall designate the numbers assigned to them.
- h) The nomenclature used to identify switches or circuit breakers shall:
  - 1) Where they disconnect mains or services, it shall designate this fact together with suitable differentiating nomenclature where more than one service or mains is involved.

- 2) Where they control feeders, it shall designate the feeder number and the name of the load supplied.

#### **27.1.30 Manufacturer's Identification**

- 1) Required for each factory fabricated fixture or equipment item; applied on items to be concealed when installed and normally closed; readily visible and readable when opened.
- 2) Such labels or nameplates must be those standard with manufacture, shall be non-corrosive and durable, and permanently attached.
- 3) Labels or nameplates shall state fixture or equipment item type, model, number, rating, current characteristics etc.

#### **27.1.31 Circuit Directories**

- 1) Required for each panel containing electrical control or safety devices; installed at the back of panel doors.
- 2) Each directory correlated with panel as arranged and installed and in typewritten form only.
- 3) Each directory protected and retained by suitable frame and clear glass or plastic cover.

#### **27.1.32 Keyed Locks and Switches**

- 1) Locks and switches required to be keyed shall be master-keyed to one set or sets for common types of facilities such as panelboards and for various different locations such as different buildings or areas of usage.
- 2) Exact requirements for keying shall be as directed by the Engineer at later date after commencement of the work.
- 3) Keys Required:
  1. Master keys and change keys: not less than 6 each.
  2. Provide duplicate sets; one set to be maintained at all time under security of Employer's security personnel.

#### **27.1.33 Attachment to Structures**

- 1) General:
  - a) Types appropriate for materials and conditions encountered and only as shown, specified or approved.
  - b) Sizes adequate for loads and forces involved.
  - c) Cutting or welding to structure for support permitted only as and where specified or approved by Engineer for each specified condition or location.
  - d) Supporting piping or equipment by attachments directly to metal decking not permitted.
  - e) Items Throughout : Steel shall be hot-dip galvanized or corrosion resistant painted, plated or treated by approved methods.
- 2) Continuous Supports:
  - a) Manufacturer's standard prefabricated type of C-Channel; roll-formed from steel strip thickness not less than 2.5 mm; in standard length units for minimum of splices.

- b) Complete with matching splices covers, insert devices suitable for hanger rods, etc. required to be supported.
  - c) Secure to overhead concrete using unit anchors; set through pre-punched holes in C-Channel webs.
- 3) Unit Anchors:
- a) Manufacturer's standard type of steel insert bolts designed for use in hardened concrete, with pre-tested and predetermined load values; and in various types and sizes suitable for varying installation requirements.
  - b) Each unit selected in accordance with manufacturer's certified load carrying capacity tables, as approved.
  - c) Each unit selected to safely support works required and when under full load conditions; and as appropriate to which attachment is being made.
  - d) Determine selections using Factor of Safety not less than 5 times actual or real loads to be supported
  - e) In any and all cases, bolt shank diameter shall be not less than 15 mm
- 4) Other Consideration:
- a) Heavy Items in Steel Framing: Machine bolts, nuts and washers set through drilled holes.
  - b) Light Items to Steel Framing: Machine screws set into drilled and tapped holes or set through drilled holes and with nuts and washers.
  - c) Light Items in Sheet Metal: Headed fasteners with threads designed for sheet metal work; self-drilling, self-tapping.
  - d) Sizes appropriate for loads to be supported and as approved.
- 5) Not permitted in lieu of attachments as specified.
- a) Wood blocking embedded in concrete.
  - b) Wood, fibre, plastic or lead type inserts.

### 27.1.34 Protective Coating

#### 1) General

- a) Required for materials and equipment not otherwise pre-finished, protected or included for field painting.
- b) Painting work and materials required herein and not otherwise specified shall be in accordance with applicable requirements specified in Section TS 24.
- c) Includes all locations, whether exposed or concealed in completed work.

#### 2) Painting

- a) Unless otherwise specified, all raceways, conduits, cable trays, boxes, supporting devices and other materials and equipment seen visibly from outside shall be painted in accordance with the Engineer's instructions.
- b) Metalwork which is normally painted in the factory before dispatch, shall be prepared by filing or wire brushing and rubbed down or similarly prepared to a smooth and rust-free finish and then given one prime coat, one or more undercoats and one more top coats of approved paints. The second top coat shall be of a different shade of colour. Metalwork installed to outdoor shall be painted with epoxy to avoid sea air corrosion.
- c) Metalwork which is normally painted on Site shall be prepared as aforesaid and given one coat of approved preservative paint before leaving the factory.

- d) Metalwork which will be erected in the open shall be given top coats of bitumen based paint with appropriate approved primer and undercoat.
- e) Where aluminium paint is specified the paint used for the undercoat shall be of the same quality as the top coat but slightly coloured by the addition of washing blue.
- f) The inside of control cubicles, cabinets, etc. where condensation is liable to occur shall be coated with approved anti-condensation composition.
- g) All bright metal parts shall be covered before shipment with an approved protective compound and protected adequately during shipment to Site. The protective coatings will not be removed until absolutely necessary.

### **27.1.35 Safety Equipment and Notices**

- 1) Copies of all statutory safety notices, regulations and instructions for resuscitation and treatment after electrical work; all surface-treated with clear varnish, in suitable wall mounted frames.
- 2) Danger signs on the motor centres/control panels.
- 3) A varnished and mounted (on suitable hard backing) and framed (in glass panel) copy of the main single line diagrams showing clearly the full details of the electrical and mechanical system as supplied and installed.

### **27.1.36 Units of Measurement**

Units for measurement of electrical work under this contract are lump sum items or set and shall include all items and works necessary for their completion. Other electrical items not specified nor indicated in the Bill of Quantities, but necessary for the completeness of the entire electrical systems, shall be considered part and incidental to the particular items specified in this Specification and included in the Bill of Quantities and shall not be measured separately.

## **27.2 POWER INTAKE CABLE WORKS**

### **27.2.1 Description of Works**

This section covers the technical requirements for the materials, workmanship, fabrication and installation of power intake cable works, to include but not limited to, all cabling works between the secondary connection terminal of PLN's distribution transformer and the Generator Control Panel located inside the Electrical Building in the Simongan Weir Management Complex.

### **27.2.2 Materials**

Materials shall conform to the respective specifications and standards and to the specifications herein. Electrical rating shall be as indicated.

#### **27.2.2.1 Cable**

Cable shall be 380 V Class XLPE (Cross-linked Polyethylene insulated and PVC sheathed) cable.

#### **27.2.2.2 Conduit**

Conduit shall be PVC (Polyvinyl Chloride) conduit for electrical cable installation.

### **27.2.3 Installation**

#### **a. Conduit**

Underground conduit shall be installed to 600 mm in depth and excavation and back filling shall conform to the requirements of Section TS 2, Earth Works.

Bends of conduit shall be so made that conduit will not be injured and that internal diameter of conduit will not be effectively reduced.

Field bends shall be made only using bending equipment intended for the purpose and with radius of curve of inner edge of bends not less than 6 times nominal diameter of conduit.

All joints between lengths of conduit, and between conduit and couplings, fittings and panel shall be made by a method approved for the purpose.

Where the conduit passes through the building walls and floors, holes shall be completely filled using suitable non-flammable and waterproof sealing materials.

#### **b. Cable**

Cable shall be full-length cable and continuous from origin to the panel termination without splices in intermediate.

All termination of the cable shall be protected from accidental contact, deterioration of coverings and moisture by the use of terminating device and materials.

#### **c. Grounding**

The neutral line of the service cable shall be grounded.

Grounding elect rods shall be copper bars of 15 mm diameter and 1500 mm length.

Grounding conductor shall be bare soft-drawn copper wire and sectional area of wire shall be not less than 70 mm<sup>2</sup>.

## **27.3 CONTROL PANELS**

### **27.3.1 Description of Works**

The works comprises the supply, installation, testing and commissioning of the following control panels:

- Generator Control Panel
- Remote Control Panel
- Local Control Panel for Flushing Gates
- Local Control Panels for Main Flood Diversion Gates

### **27.3.2 Requirements for Control Panels**

#### **27.3.2.1 Enclosure**

Local control panels shall be of the free-standing outdoor type. They shall be weather-proof within steel cabinets made of 3 mm minimum thickness steel plate, damp proof, dust proof and shall have a full-face lockable doors.

The remote control panel shall incorporate the same features as the local control panel but shall be of the indoor type.

The remote control panels shall be of the free-standing indoor type. It shall be a steel cabinets made of 3 mm minimum thickness steel plate, damp proof, dust proof and shall have a full-face lockable doors.

Interior partitions shall have a minimum thickness of 1.6 mm.

Index of Protection of all enclosures shall be IP 52.

All enclosures shall be strongly build specifically designed to enclose equipment scheduled or shown and withstand vibration or shock caused by operation of such equipment.

Metal components shall be factory pre-treated, primed and baked enamel finished.

Colour will be selected from manufacturers standard colours available.

All doors shall be fully open-able for ease of installing or removing equipment or devices.

Ventilation opening shall be provided to required panels.

All enclosures shall be connected to the grounding rod by the PVC insulated wire of 25 mm<sup>2</sup>.

#### 27.3.2.2 Circuit Breakers

The circuit breakers installed to the Main Control Panel shall be 380 V Class MCCB (Moulded Case Circuit Breaker) rated as shown on the drawings.

#### 27.3.2.3 Wiring in Control Panels

Wiring in panels shall consist of chloride vinyl cable with the diameter of at least 2 mm<sup>2</sup>, and shall be connected with outside points on terminal plates. All terminals shall consist of pressure connectors.

#### 27.3.2.4 Visibility of Indicators

All devices installed on the front face or doors such as meters, meter switches, circuit breakers, indication panels and alarm buzzer shall be arranged in an orderly, systematic fashion so as to be legible and readily readable.

Ammeter, voltmeter, gate position indicator displays shall be installed such that they are visible through windows from the outside of gate houses.

#### 27.3.2.5 Marking of Cables

Cables connected at the rear face shall be marked with terminal numbers at both ends and the relevant numbers shall be included on the plug board chart.

#### 27.3.2.6 Dehumidifiers

Each control cabinet shall be equipped with a dehumidifier of sufficient capacity to keep equipment inside the control cabinets dry. The dehumidifiers shall be of automatic compulsive convection type. When the humidity inside control panels exceeds 60%, the dehumidifiers will start operation of compulsive convection.

#### 27.3.2.7 Audible Alarms

Sound level and quality of chime and alarm bell shall be sufficiently loud so as to be audible during normal operation.

#### 27.3.2.8 Separate Circuit Requirements

The space heater circuit, dehumidifier circuit and motor circuit shall be constructed independently and each shall be equipped with circuit breakers.

### 27.3.2.9 Leader Linings

The leader lining from single phase shall be conducted following consideration of the loading balance of each phase.

### 27.3.2.10 Summary of General Requirements for Control Cabinets

Control cabinets shall be equipped with the following for easy and reliable control.

Items	Quantity
Main Switch (with alarm contact)	1 piece
Switch (with alarm contact)	Required
Voltmeter (1.5 grade)	1 piece
Ammeter (1.5 grade)	1 piece
Positive-negative magnetic switch	Required
3E relay	Required
Auxiliary relay	Required
Displays (current, raise, lower, stop, failure, etc.)	Required
Push button for switch	Required
Space heater (with thermostat)	1 piece
Dehumidifier	1 piece
Material for wiring	Required
Plug receptacle for working (200V, 100V)	1 piece each
Terminate plate	Required
Name plate	for each equipment
Door (full-face door, small door for operating), with lock	1 piece each
Lighting in cabinet (fluorescent lamp of 10 W)	1 piece
Chime, alarm bell	1 piece each
Other required equipment	Required

### 27.3.3 Installation

Control Panels shall be erected with adjacent components accurately aligned and all components shall be set square, plumb and level and full bearing on supporting base frame and floor.

## 27.4 SWITCHBOARD

### 27.4.1 Description of Works

The work comprises the supply, installation, testing and commissioning of a .....switchboard in accordance with the drawings, the specifications and the instructions of the Engineer.

### 27.4.2 Requirements for Switchboard

*Specification to be advised at a later date*

### **27.4.3 Installation**

*Specification to be advised at a later date*

## **27.5 GENERATOR SYSTEM**

### **27.5.1 Description of Works**

The work comprises the supply, installation, testing and commissioning of an indoor use, metallic cubicle-type generator system in accordance with the drawings, the specifications and the instructions of the Engineer.

### **27.5.2 Quality Assurance**

Operating Experiences Requirements: Engines to be installed shall meet all of the operating experience requirements listed below:

- a) Only electrical generation service is considered as equivalent experience. Engine driving pumps or compressors, or those in marine propulsion or railroad service, are not acceptable.
- b) Only experience on the same engine model is acceptable. Engine model is considered to be given series or class of identical bore and stroke and of the same type of engine, such as in line or Vee. In - line and Vee engines with identical bore and stroke are considered as two separate models of engines.
- c) Only experience at the identical rotational speed as that which is offered is acceptable.
- d) Only experience at the identical or higher brake mean effective pressure as that which is offered is acceptable.
- e) Only experience with fuel oil is considered acceptable experience.

### **27.5.3 Shop Drawings and Calculations**

Further to the requirements of GS 1.4 and GS 1.5, the Contractor shall submit shop drawings and calculation for diesel engine generating unit and auxiliary equipment, including the following:

- a) Certified outline, drawings arrangement (setting plan), and anchor bolt details. Drawings shall show the total weight and centre of gravity of the assembled equipment on the mounting skid.
- b) General requirement drawings showing location of all auxiliary equipment in relation to the diesel generating unit.
- c) Piping schematics for fuel oil, lubricating oil, integral with diesel engines
- d) Critical speed calculations.
- e) Electrical elements, schematics and wiring diagrams, including details of the safety shutdown systems and main generator circuit breaker trip system.

### **27.5.4 Certified Test Reports**

- a) Diesel engine shop tests.
- b) Generator shop tests.
- c) Diesel engine driven electric generator set shop tests.

### **27.5.5 Safety Requirements**

Safety requirements shall comply with manufacturer's recommendation.

## 27.5.6 Products

- a) The generator system shall, as a minimum, be in accordance with the requirements of this Specification and shall be the manufacturer's standard commercial product with any added features needed to comply with the requirements. Additional or better features which are not specifically prohibited by this Specification, but which are a part of the manufacturer's standard commercial product shall be included in the generator set being furnished. "Standard commercial product" is defined as a product which has been or will be sold on the commercial market through advertisements or manufacturer's catalogues, or brochures, and represents the latest production model.
- b) The Contractor shall furnish new materials of high quality which will give long life and reliable operation. Equipment shall not have been in prior service except as required by factory tests. Workmanship shall be of highest quality in every detail.

## 27.5.7 Diesel Generator Set and Auxiliary Equipment

The generator set shall consist of a diesel engine connected to an alternating current generator with brushless excitation system mounted on a steel sub-base and provided with all necessary accessories, auxiliaries, and control equipment resulting in a complete self-contained unit capable operation.

Set shall be arranged for manual starting. Generator set must be capable of providing full rated power within 30 seconds after starting.

### a) Equipment Rating and Capability

Diesel - engine generating set shall have a continuous rating as indicated at 0.8 power factor for 3 - phase unit. Both the engine and generator set shall be capable of satisfactorily carrying a load 10 percent in excess of the continuous hours out of any 24 consecutive hours.

Gross kW rating of the diesel generating set shall be not more than the figure obtained by multiplying the delivered shaft horse power rating of the engine by 0.746 and by the overall efficiency of the generator shall allow for power to operate the exciter, including power consumed in losses and in windage and friction for generator and rotating exciter.

Rated net capacity of the generating set is defined as gross electrical power requirements of "engine assemble", as defined in NEMA publication "Standard Practices for Stationary Diesel and Gas Engine". All auxiliary equipment furnished shall be designed for continuous duty at 110 percent of rated net capacity of generating set.

The generating set shall be rated for the kW indicated at 0.8 power factor 3 phase 380 volt.

### b) Critical Speeds

The complete diesel - electric generating set shall be free of critical speeds of either a major or minor order that will endanger satisfactory operation of the set. Satisfactory operation will be considered to be endangered if torsional vibration stresses exceed 350 kg/cm<sup>2</sup> within 10 percent above or below rated engine speed. The Contractor shall submit three (3) copies of a summary of computations of critical speeds to the Engineer.

## 27.5.8 Design and Construction

Rotating or reciprocating parts, or other parts that may present a hazard to operating personnel shall be isolated or shielded to minimise danger. Design characteristics shall limit operating temperatures at critical points of maximum wear at full - load operating conditions.

## 27.5.9 Generator Diesel Engine and Accessories

### 27.5.9.1 Type and Requirements

The generator diesel engine to be furnished shall drive the A/C generator and shall be base mounted.

The diesel engine shall be of vertical, single acting, solid injection, 4 stroke cycle, cold starting, air cooled with radiator diesel engine.

Main parts shall possess excellent properties against heat, pressure, erosion and wear. All parts shall be manufactured to ensure the highest accuracy and precision by means of limit gages, special jigs, fixtures, etc.

Materials used, manufacturing and performance shall be in accordance with JIS specification or equivalent.

The design conditions for the main engine shall be as follows:

ITEM	TYPE AND REQUIREMENTS
1. Rating	3-Phase, 380 V, 50 Hz, 250 kVA
2. 1 Hour rating output	Not less than 110% of Rating Capacity
3. Continuous operating speed: (rpm)	3000
4. Bore of Cylinders: (mm)	
5. Number of Cylinders:	
6. Specific fuel Consumption	
7. Starting System:	
8. Location of Operation:	Electrical Building, Simongan Weir Management Complex
9. Engine cooling system:	Radiator
10. Engine Lubrication System:	Forced lubrication by use of gear pump mounted on engine
11. Fuel Oil Recommended:	

*Note: Blank items are to be completed by the Contractor.*

### 27.5.9.2 Manufacturing and Materials

#### a) Cylinder Block, Head and Crankcase

The cylinder block, head and crankcase shall be made of cast iron. Replaceable wet type cylinder liners shall be made of high grade cast iron.

#### b) Crankshaft

The crankshaft shall be of the forged, one piece type made of carbon steel. Bearing surfaces shall be of sufficient size to safely sustain all bearing loads

imposed, and shall be heat - treated to provide resistance against shocks and wear.

c) Camshaft

The camshaft shall be made of carbon steel, driven by gears from the crankshaft. The hard - wearing surfaces shall be treated by high frequency shall be treated by high frequency induction hardening.

d) Piston and Piston – Pin

Pistons shall be trunk and made of special cast iron or high grade heat treated light alloy, and shall have sufficient resistance against heat and pressure. Piston rings shall consist of two or three compression rings and one or two oil scraping rings. The piston - pins shall be of full floating type and completely carbonised.

e) Connecting Rods

Connecting rods shall be made of forged steel and designed for using replaceable and precision insert type crank pin bearings. A drilled passage for piston - pin lubrication shall be incorporated.

f) Bearings

The bearings for both main and crank pin journals shall be precision insert bearings and readily replaceable. The piston - pin metals shall be of the special phosphorous bronze.

g) Fuel Injection Nozzle

Each one set of fuel pump with plunger, for adjusting injection volume and timing, shall be provided for each cylinder.

The injection nozzle shall be pin hole type and designed to adjust the needed injection pressure automatically and to meet with the any load conditions immediately.

h) Governor

The governor is of mechanical and/or hydraulic type and so sensitive in operation that it is able to adjust of loads automatically and immediately. Engine speed variation is calculated not more than 100 % (instantaneous) and 5 % (steady).

i) Exhaust System

The diesel engine exhaust gas shall be released to atmosphere outside the house through exhaust pipe works and silencers. All exhaust pipe work inside the house shall be lagged by an approved thermal insulation materials as shown on the Drawings and shall be a standard accessories of the diesel engine.

The silencer shall be positioned as shown on the Drawings. The exhaust system shall be complete with expansion bellows, support structures and brackets where necessary.

### 27.5.9.3 Accessories

The accessories of the diesel engine to be furnished shall be as follows:

a) Gauges

Tachometer, lubrication oil pressure, etc.

b) Thermometer

Lubrication oil, cooling water, etc.

c) Auxillary Priming Pump

Wing type lubrication oil pump.

- d) **Strainer and Cooler**  
Fuel oil strainer, lubrication oil strainer, lubrication oil cooler, suction air cooler, etc.
- e) **Safety Devices**  
Lubrication oil pressure relay, cooling water high temperature relay, over speed relay, cooling water flow - sight glass, etc.
- f) **Miscellaneous**  
Exhaust system has turbo - supercharger, pressure indicator cock for each cylinder, flywheel and dual air reservoir tanks, flexible pipe joints, installation bolts, etc.

### 27.5.10 Diesel Generator and Excitation Systems

- a) **Generator**  
The generator shall be 380 V, 50 hertz, 0.8 power factor, 3 - phase, alternating-current type with revolving field. The speed of the generator shall be that of the diesel engine. The generator shall be capable of carrying continuously a 0.8 power factor load equal to the gross kilowatt rating of the diesel generating unit, and to carry a 0.8 power factor load 10 percent in excess of the gross kilowatt rating of the diesel generating unit for 1 continuous hour out of any period of 24 consecutive hours at normal voltage and with a temperature rise of not more than 80° C as measured by resistance based on 40° C ambient temperature. Enclosures shall be the general - purpose open type with ventilating openings covered with removable screens a mesh not larger than ½ inch.  
  
The generator shall conform to ANSI C50.10, and NEMA MG -1. The generator shall have form - wound coils and Class H insulation. The generator and flywheel shall have sufficient flywheel effect to meet the requirements of regulation and operation as specified. The rotor shall be continuous or interconnected armature windings. The generator rotor shall be mounted on an extended shaft which shall be coupled rigidly to the engine crankshaft. Impellers shall be mounted on the rotor for cooling the generator. The rotor shall be capable of safe operation at a speed 25 percent in excess of its rated synchronous speed. The generator armature, field, and ground leads shall have clamp - or crimp - type lugs or connectors for electrical connections. Terminal markings shall conform to NEMA MG -1.
- b) **Excitation and Voltage Regulation System**  
The excitation system shall be the integral brushless type consisting of a rotating AC exciter and rectifier diode assembly together with a static - type voltage regulating system and including surge protection and the required accessories. The system shall serve as an individual excitation and regulation system for the generator specified herein, and there is no requirement for parallel operation with other exciters.  
  
The excitation system shall have a continuous current rating of not less than the generator excitation current required when the generator operates at 105 percent rated voltage under the condition of continuous rating requiring maximum field current. The voltage rating of the system shall be as required to match the generator field requirements. The excitation system response ratio shall not be less than 0.5 and the ceiling voltage shall not be less than 120 percent of rated voltage.
- c) **Exciter**  
The exciter shall be a rotating AC generator having a rotating armature on the

rotor spider and a stationary field on the stator frame. The exciter insulation shall be Class B and the temperature rise shall not exceed 70° C when measured by resistance based on a 40° C ambient temperature.

**d) Rectifier**

Rectifiers shall be full - wave silicon diode type, with each diode protected by individual fuses. The rectifiers shall be mounted on the rotating part of the exciter to convert AC exciter output to DC for the main generator excitation. Connections shall be provided between the exciter, rectifiers, and generator field without use of brushes or slip rings.

**e) Voltage Regulator**

The voltage regulator shall be a completely solid - state type to control the generator voltage by controlling of the exciter field. The regulator shall be suitable for mounting in the generator control panel. The regulator shall control the generator exciter field as required to maintain a constant and stable generator output voltage within plus or minus ¼ of one percent of nominal for all steady - state loads from no load to full load, including a 5 percent variation in frequency and the effects of field heating. The regulator shall be designed for single - phase voltage sensing. Electromagnetic interference suppression shall be integral part of the regulator. Thermal protection for power semi- conductors, inherent over-voltage, and fuse protection shall be provided internally in the regulator. No electrolytic capacitors, vacuum tubes, or electromechanical relays shall be used in the voltage regulator. The regulator shall have provisions for switching to manual control to allow the generator voltage to be controlled either manually or automatically. The following regular components shall be mounted on the front of the generator control panel.

a) Voltage adjusting rheostat

b) Manual voltage control with adjusting rheostat

**f) Engine - Generator Instruments and Controls**

NEMA ICS 1, 2, 3, 4 and 6 shall be applied to engine - generator instruments and controls.

**g) Generator Controls and Instruments**

NEMA ICS 1, 2, 3, and 4 shall include the components listed below. Instruments shall comply with ANSI C39.1.

1) Voltmeter and Ammeter: Semi-flush mounted direct indicating type, not less than 110 mm nominal round or square, 180° C arc, with accuracy of 2 percent of full scale.

2) Frequency Meter: Dial type.

3) Control Switches: Voltage and ampere ratings suitable for the intended use. Contacts shall be rated in accordance with NEMA Standards ICS 2 - 125.

4) Generator Output Circuit Breaker: Moulded case type, trip-free, and shall be mounted to allow operation from outside the control panel. Frame size shall be adequate for generator amperage when operating at standby rating, and adjustable trip shall be provided. Lugs shall be provided for electrical connections.

5) Voltage adjustment rheostat.

6) Panel lights and control switch.

7) Alarm indicating panel.

### **27.5.11 Base Assembly and Enclosure**

- a) **Engine - Generator:** Engine - Generator shall be mounted on a fabricated steel skid base suitable for supporting, transportation, and skidding engine and generator without damage to equipment or alignment.
- b) **Vibration Isolators:** Vibration isolators shall be provided to isolate the engine - generator set from the building floor. At least four isolators, as recommended by the isolator manufacturer, are required. The isolators shall be manufactured by a firm specialising in this product, and the unit shall be specifically listed for this application and have a maximum deflection of 25 mm.

### **27.5.12 Treatment and Painting**

All parts, including engine subject to high temperature, shall be painted in accordance with manufacturer's standards. The generator and all associated electrical equipment shall be thoroughly cleaned and treated prior to painting. Colour shall be manufacturer's standard.

### **27.5.13 Execution**

#### **27.5.13.1 Installation**

Installation shall conform to the requirements of PEC and NFPA 70.

#### **27.5.13.2 Diesel Engine Generator**

Diesel engine generator shall be installed on a concrete foundation as indicated. Vibration isolators shall be provided to isolate vibrations from the diesel engine generator set to the foundation.

#### **27.5.13.3 Testing**

The following tests shall be performed on the generator set system provided. The Contractor shall provide all test equipment and personnel and submit three (3) copies of all test results.

##### **a) Factory Tests**

The engine - generator shall be subjected to the manufacturer's standard run - in and conditioning tests.

Following the run - in tests, the engine - generator set shall be tested at rated speed and voltage for 8 hours of continuous operation with 2 hours each at 50, 75, 100 and 110 percent of rated load, consecutively, 0.8 power factor. The Contractor shall confirm generator frequency, phase, current, and voltage and record at 15 - minute intervals. The Contractor shall tests run on the voltage regulator to determine the variation in terminal voltage under conditions of constant load, and under conditions of abrupt load changes to determine the maximum voltage change during the surging period and the time required.

##### **b) Speed Governing Test**

Engine speed governing system shall be tested in accordance with ASME PTC26.

##### **c) Field Tests and Inspections**

The Contractor shall perform all field tests and trial operations, and conduct all field inspections. The Contractor shall provide all labour, equipment, and requirements, including water, fuel, and lubricants required for tests. The

Contractor shall give sample notice of the dates and times scheduled for tests, trial operations, and inspections which require the presence of the Engineer. All deficiencies found shall be rectified and work affected by such deficiencies shall be completely re-tested at the Contractor's expense. Fields tests shall include the following:

- 1) Demonstrate proper operation of all system
- 2) Conduct 3 - hour load run utilising Contractor - furnished portable load banks as follows:
- 3) ½ load - one hour
- 4) Full load - two hours

## **27.6 POWER SUPPLY AND CONTROL CABLING**

### **27.6.1 Description of works**

This clause covers the technical requirements for the equipment, materials, workmanship, fabrication and installation of power and control cabling works between the generator control panel and the switch board, between the switch board and the remote control panel and all of the feeder cables to the local control panel from both the switch board and from the remote control panel.

### **27.6.2 Equipment and Materials**

Equipment and materials shall conform to the respective specifications and standards and to the specifications herein. Electrical rating shall be as indicated.

#### **27.6.2.1 Cable**

Cable shall be 380 V Class XLPE (Cross-linked Polyethylene insulated and PVC sheathed) cable.

All cables shall be installed into conduit run as specified hereinafter.

#### **27.6.2.2 Conduit**

Conduit shall be ridged steel conduit for electrical cable installation.

Both internal and external surface of the conduit shall be either galvanized or painted.

Conduit shall be practically straight, uniform in thickness.

#### **27.6.2.3 Pull boxes**

The pull boxes shall be made of sheet steel thickness not less than 1.6 mm and galvanized or painted.

The pull boxes installed in outdoor area shall be of waterproof type.

### **27.6.3 Installation**

#### **27.6.3.1 Conduits**

The conduit runs for cabling between the remote control panel and the weir bridge shall be buried in a cable trench as shown in the Drawings. Cabling for building works, described elsewhere, shall also be buried in the same cable trench.

All conduits installed to exposed location shall be installed and supported in a rigid and satisfactory manner.

Conduit runs between pull boxes or between box and panel shall not contain more than equivalent of 4 quarter bends or 360 degrees in total.

All cut ends of conduit shall be reamed to remove rough edges.

Conduits shall be firmly fastened within 0.5 m of each pull box or panel and intermediately supported interval of less than 1.5 m.

All supports, bolts, straps, etc. shall be corrosive-resistant metal, galvanized or painted.

Joining parts of conduits, conduit and pull box that may become energised shall be bonded for electrical continuity.

Bend of conduit shall be so made that conduit will not be injured and that internal diameter of conduit will not be effectively reduced.

Field bends shall be made only using bending equipment intended for the purpose and with radius of curve of inner edge of bends not less than 6 times nominal diameter of conduit.

Where the conduit passes through the building walls, holes shall be completely filled using suitable non-flammable and waterproof sealing materials.

#### **27.6.3.2 Cable**

Cable shall be full-length cable and continuous from origin to the end termination without splices in intermediate.

All termination of the cable shall be protected from accidental contact, deterioration of coverings and moisture by the use of terminating device and materials.

#### **27.6.3.3 Grounding**

All panels for the equipment shall be grounded to the grounding rod installed near the panels.

Grounding elect rods shall be copper bars of 15 mm diameter and 1500 mm length.

### **27.7 EXTERIOR LIGHTING**

#### **27.7.1 General Requirements**

Clause 27.1 "General Requirements", applies to this Section with the additional and modifications specified herein.

#### **27.7.2 Description of Works**

The work includes exterior lighting on the Simongan Weir and its approach bridges.

#### **27.7.3 Submittals**

The Contractor shall submit data, shop drawings, and reports which shall employ the terminology, classifications, and methods prescribed by the IES Lighting Handbook, as applicable for the lighting system specified.

##### **1) Manufacturer's Data**

When data that describe more than one type, size, model, or item is submitted, the Contractor shall clearly mark the data to indicate which type, size, model, or item is being provided. Data shall be sufficient to show conformance with specified requirements.

- a) Luminaires
- b) Poles and Brackets

- c) Photocell Switch
- d) Lighting Contractor
- 2) Shop Drawings
  - a) Luminaires shall include dimensions, accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratios, aiming diagram and candlepower distribution data shall accompany shop drawings.
  - b) Poles shall include dimensions, wind load, pole deflection, pole class, and other applicable information.

## 27.7.4 Products

### 27.7.4.1 Luminaires

UL 1572 or NEMA FA 1 shall be applied to luminaires. The Contractor shall provide luminaires complete with lamps of the number, type and wattage indicated. The details, shapes, and dimensions are indicative to the general type desired, but are not intended to restrict the selection of luminaires from any particular manufacturer. Luminaires of similar designs and equipment, light distribution and brightness characteristics, and of equal finish and quality will be acceptable as approved.

- 1) Lamps: Lamp shall be high pressure sodium 100 and 150 Watts, 220 as shown on the Drawings.
- 2) Ballasts for High-Intensity-Discharge (HID) Luminaires: UL 1029 and ANSI C82.4 shall be applied, and shall be constant wattage autotransformer (CWA) or regulator, high power factor type. Ballasts shall be designed to operate on the voltage system to which they are connected. Single lamp ballasts shall be provided with a minimum starting temperature of minus 30 degrees Celsius ( $^{\circ}$  C). Ballasts shall be constructed so that open circuit operation will not reduce their average life. HID ballasts shall have a solid state igniter/starter with an average life in the pulsing mode of 10,000 hours at an igniter/starter case temperature of  $75^{\circ}$  C. "Average life" is defined as the time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

Luminaire shall be similar to Philips SGS series or approved equal.

### 27.7.4.2 Lighting Contactor

NEMA ICS 2 shall be applied to lighting contactors. The Contractor shall provide electrically operated, mechanically held contactors rated as indicated. The Contractor shall provide lighting contactor in NEMA 1 enclosure conforming to NEMA ICS 6. Contactor shall have silver alloy double-break contacts and coil clearing contacts and shall require no arcing contacts. Contactors with hand-off automatic on-off selector switch shall be provided.

### 27.7.4.3 Photocell Switch

Photocell switch shall be in accordance to UL 773 or UL 773a. The Contractor shall provide hermetically sealed cadmium sulphide cell rated, 60 Hertz AC with single-throw contacts 1000 watts, and voltage as indicated. Switch shall be mounted in a cast weatherproof aluminium housing with swivel arm designed to mount on or beside each luminaire. The switch shall turn on below 30 Lux and off at 30 to 100 Lux. A time delay shall prevent accidental switching from transient

light source. A directional lens shall be mounted in front of a turn off condition. Switch shall aim according to the approved manufacturer's recommendations.

#### **27.7.4.4 Poles**

Poles shall be galvanized steel, 6 and 7 meters high, designed for wind loading of 175 KM per hour determined in accordance with AASHTO LTS-1 while supporting luminaire having effective projected areas indicated. Unless otherwise shown on the Drawings, poles shall be embedded or anchor-base type designed for use with steel box and underground supply conductors.

#### **27.7.4.5 Brackets and Supports**

Slip-fitter or pipe-threaded brackets may be used, but brackets shall be coordinated to the luminaires provided, and all brackets for use with one type of luminaire shall be identical. Special mountings or brackets shall be as indicated and shall be of metal which will not promote galvanic reaction with the luminaire head.

#### **27.7.4.6 Anchor Base Assemblies**

Anchor bolts shall be steel rod having a minimum yield strength of 3,500 kg/cm<sup>2</sup>; the top 300 mm of the rod shall be galvanized per ASTM A 153.

### **27.7.5 Execution**

#### **27.7.5.1 Installation**

ANSI C2, NFPA 70 shall be applied and to the requirements specified herein.

Poles shall be mounted anchored to a reinforced concrete foundation with base plates, anchor bolts, standard nuts and washers as shown on the Drawings.

#### **27.7.5.2 Grounding**

The Contractor shall ground non-current-carrying parts of equipment including metal poles as specified in Sub-Section 5.2 "Exterior Electrical Works". Where the copper grounding conductor is connected to a metal other than copper, the Contractor shall provide specially treated or lined connector suitable for this purpose.

### **27.8 INTERIOR LIGHTING**

The requirements for interior lighting are specified in Section TS 28, Building Works.

### **27.9 INTERIOR WIRING SYSTEM**

The requirements for interior wiring for building works are specified in Section TS 28, Building Works.

### **27.10 LIGHTNING PROTECTION**

#### **27.10.1 General Requirements**

Clause 27.1 "General Requirements" shall apply plus the additions and modifications specified herein.

### 27.10.2 Applicable Publications

The publications listed below form part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

- 1) American National Standards Institute (ANSI) Publications:  
C2-1984 National Electrical Safety Code NESC
- 2) National Fire Protection Association (NFPA) Publications:  
70-1987 National Electrical Code (NEC)
- 3) Underwriters' Laboratories Inc. (UL) Publications:  
467-72 Electrical Grounding and Bonding Equipment (1982)
- 4) Institute of Integrated Electrical Engineers of the Philippines, Incorporated.  
1985 Part I Philippine Electrode Code

### 27.10.3 Materials and Equipment

Materials and equipment shall conform to the respective Specifications and standards and to this Specifications. The electrical characteristics shall be as indicated.

- 1) Grounding electrodes shall be cone pointed, sectional copper clad steel, 20 mm by 3.00 meters long.
- 2) Grounding conductors shall be bare soft-drawn copper wire, 22 mm<sup>2</sup> minimum size unless otherwise indicated or specified.
- 3) Lightning Protection materials shall conform to class 1 installation.
  - a) Air Terminal shall be solid copper 9.5 mm in diameter.
  - b) Main conductor cable shall be stranded, bare soft-drawn copper 29 mm<sup>2</sup> cross-sectional area.
  - c) Secondary conductor shall be 14 strands of 0.09 mm<sup>2</sup> copper.
- 4) Connections - connections shall be by exothermal welding unless otherwise indicated.

### 27.10.4 Installation

- 1) The complete duct bank shall be provided with a ground wire (counterpoise), 22 mm<sup>2</sup> bare copper, stranded, soft-drawn, laid and fastened on top of the length of concrete envelope. The ground wire is brought into each handholes and braced to the ground rod.
- 2) Each lighting pole shall be grounded at the base by ground lugs and ground conductor connected to a ground electrode. The ground electrodes are then connected in series forming a continuous ground grid.
- 3) Service entrance equipment for each facility or building shall be grounded through a grounding bus connected to a ground electrode.
- 4) The down conductors for lightning protection system shall be connected to a ground grid system, separate from the equipment grounding.
- 5) Ground rods (electrodes) and grounding conductors shall be laid 600 mm below grade line.

## **27.11 AIR VENTILATION SYSTEM**

### **27.11.1 Description of Works**

The air ventilation system shall consist of ventilation fans in the roof of the Electrical Building in which the diesel generator unit is housed

### **27.11.2 Technical Requirements**

The ventilation fans shall be AC motor driven type (380 V) 3-phase) roof fan equipped with hood. The ventilation fans shall automatically operate when the diesel generator is operating. Manual starting and stopping of the ventilation fans shall be possible.

The motor capacity of ventilation fans shall be 1.5 kW and the ventilation capacity shall be not less than 400 m<sup>3</sup> per minute.

### **27.11.3 Installation**

The Contractor shall supply and install the ventilation fans together with any anchor or supporting structure, wiring and everything required for the proper operation of the ventilation fans.

## **27.12 ELECTRICAL TESTING**

### **27.12.1 General**

The provisions of clause 27.1 shall apply to electrical testing.

### **27.12.2 Scope of Work**

- 1) This Section sets forth testing requirements applicable to Works.
- 2) Compliance with provisions herein shall be Contractor's responsibility to provide as part of Contract Work and without separate payment therefor.

### **27.12.3 General Requirements**

- 1) Each electrical system shall prove satisfactory and acceptable in accordance with requirements throughout and under these Contract Documents.
- 2) In addition to requirements herein, tests shall also be performed as Work progresses as required by the Engineer.
- 3) Testing required herein shall be performed in the presence of the Engineer at times duly arranged for in advance, in accordance with notification requirements.
- 4) Sufficient qualified personnel, time, materials and fuels shall be allotted and provided by the Contractor as necessary to provide and perform all required tests.
- 5) The Contractor shall invite one (1) inspector (the Engineer or his representative) for two (2) man-days for the purpose of witnessing the test for all electrical panels and controls related to the weir gate operating system. The required tests shall be at the manufacturer's factory. All necessary expenses to the said inspection such as round-trip air tickets, per-diem with living allowance and land transportation charge shall be borne by the Contractor.

#### **27.12.4 Test Programs**

- 1) Quality and Demonstration tests shall be carried out and performed per programs therefor as will be prepared and issued by the Engineer after commencement of Work under this Contract.
- 2) Test programs shall also include such forms as deemed necessary and issued by Engineer; which Contractor shall utilize and execute accordingly and as applicable to various kinds and aspects of work to be tested.

#### **27.12.5 Test Reports and Records**

- 1) Reports
  - a) Forms as may be issued by the Engineer and such others as derived by the Contractor and appropriate for information and data to be recorded.
  - b) Required for such tests as are required to be performed as Work progresses, and for tests required and performed upon completion of Work.
- 2) Maintain complete file thereof.

#### **27.12.6 Non-Compliance**

- 1) Failure of Work to pass required tests or otherwise not meet specified requirements; as indicated by test records; shall be sufficient reason for considering work as non-compliant and subject to disapproval or rejection of entirety of respective work.
- 2) Contractor's failure to make required tests shall be considered same as for Work not in compliance and shall be sufficient reason for rejecting entirety of Work not so tested.
  - a) Testing of respective Work not so tested may be performed by Engineer; or by duly qualified testing agency or other personnel retained by Engineer; all at Contractor's risk and expense.
  - b) Said expenses shall mean include costs of materials and/or equipment whether purchased or rented, and fees and expense of Engineer or others incurred in or for performing such tests.
  - c) Said expenses shall be subject to recovery as they are accrued by withholding same from monies due or which may become due to Contractor under this Contract.

#### **27.12.7 Quality Test Requirements**

- 1) Quality testing shall mean to include and consist of all such examination, measuring, inspections; by visual, mechanical, instrumental or other means; as is necessary to show and prove Work so tested does in fact meet all quality requirements and performance characteristics as shown or specified.
- 2) Measurement of Grounding Resistances:
  - a) Grounding resistance of all grounding electrodes and grounding terminals shall be measured using transistor earth tester.
  - b) Grounding resistance shall be not less than the values stipulated in these Specifications; or in accordance with Philippine Electrical Code when not so specified.

- 3) Insulation Resistance Tests:
  - a) Insulation resistance between all feeders and ground, all branches and ground, and conductors of feeder/branches shall be measured by an approved means.
- 4) Relay Tests:
  - a) Characteristics of all relays shall be tested.
  - b) All relays shall be adjusted and set to secure adequate characteristics for respective system.

#### 27.12.8 Demonstration Test Requirements

- 1) Demonstration Testing shall mean to include and consist of operating systems under various and varying conditions as is necessary to show and prove the Work tested does in fact operate and function as intended under these Contract Documents.
- 2) Techniques or methods for Quality Testing shall be employed as may be necessary for certain demonstrations.
- 3) When deemed by the Engineer as practical, feasible and not inhibitive nor disruptive to Contractor's efforts, the Engineer's operating personnel shall be permitted to attend such tests or demonstrations as will be helpful to their understanding of work for which they be responsible when eventually turned over to them by the Contractor.
- 4) Tests Required: Operational and functional demonstration tests for :
  - a) Electrical equipment; individually and separately as installed.
  - b) Each and every system of for the weir gate and intake gate control systems.

#### 27.13 MEASUREMENT AND PAYMENT

##### Remote Control Panel

Payment for the remote control panel shall be made following completion of commissioning, testing, inspection and approval by the Engineer of the of the gate control system. Payments shall made in accordance with the lump sum price for the complete set entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and any other incidental costs necessary for its completion in accordance with the Drawings and the Specification to the Engineer's approval.

##### Cable Laying

Payment for cable laying shall be made following completion of commissioning, testing, inspection and approval by the Engineer of the of the gate control system. Payments shall made in accordance with the lump sum price entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and any other incidental costs necessary for the completion of all cable laying (including power and control cabling) in accordance with the Drawings and the Specification to the Engineer's approval.

##### Emergency Generator System

Payment for the emergency generator system shall be made following completion of commissioning, testing, inspection and approval by the Engineer of the of the complete emergency generator system. Payments shall made in accordance with the lump sum price for the complete set entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and any other incidental costs necessary for its completion in accordance with the Drawings and the Specification to the Engineer's approval.

### Air Ventilation System

Payment for the air ventilation system shall be made following completion of its commissioning, testing, inspection and approval by the Engineer. Payments shall be made in accordance with the lump sum price for the complete set entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and any other incidental costs necessary for its completion in accordance with the Drawings and the Specification to the Engineer's approval.

### Switching Panel

Payment for the switching panel shall be made following completion of commissioning, testing, inspection and approval by the Engineer of the gate control system. Payments shall be made in accordance with the lump sum price for the complete switching panel set entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and any other incidental costs necessary for its completion in accordance with the Drawings and the Specification to the Engineer's approval.

### Lighting Equipment

Payment for the lighting equipment for the weir and maintenance bridge shall be made following its completion, testing, inspection and approval by the Engineer. Payments shall be made in accordance with the lump sum price entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and any other incidental costs necessary for its completion in accordance with the Drawings and the Specification to the Engineer's approval.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
J.1.1	Furnishing and Installing Remote Control Panel for Gate Operation at Operation/Management Office	L.S.
J.1.2	Cable Laying	L.S.
J.1.3	Furnishing and Installing Emergency Generator System (Diesel Engine Generator Set 250 kVA with Radiator cooling system, Silencer, Exhaust system and Fuel System)	L.S.
J.1.4	Furnishing and Installing Air Ventilation System	Set
J.1.5	Furnishing and Installing Switching Panel	Set
J.1.6	Furnishing and Installing Lighting Equipment for Weir and Maintenance Bridge	L.S.