

24.6 AUXILIARY DRAINAGE PUMP SYSTEM

24.6.1 General

An auxiliary drainage pump system shall be installed in the location as shown in the Drawings to provide drainage of the retarding basin during non-flood conditions in accordance with the operating philosophy. The work includes the supply, installation, testing and commissioning of the complete auxiliary drainage system.

24.6.2 Requirements

The type and requirements for the drain pump shall be as follows:

ITEM	TYPE AND REQUIREMENTS
Type:	Vertical, submersible, electric motor-driven pump (sliding type on guide rail with self connection to flange of discharge pipe)
Capacity:	70 litre / s, Head 6 m,
Power Supply	3-phase, 380 V AC,
Number of Pumps:	2
Accessories:	Guide rail, mounting platform, raising chain, discharge piping complete with flange to pump, check valves, mounting brackets and local control panel
Control Panel:	Refer to clause TS 25.6, "Local Control Panels"
Trash Screen:	Trash screen shall be in accordance with the manufacturer's recommendation.

24.6.3 Installation and Testing

Installation and testing shall generally be conducted in accordance with clause TS 24.9, Installation and Testing.

Particular care is to be taken to ensure that the pumps readily correctly self-align and seal with the discharge pipe flanges under their own weight when in the operating position.

All electrical equipment shall be installed and tested in accordance with the section TS 25, Electrical Works.

24.7 OVERHEAD CRANE SYSTEM

24.7.1 General

The Contractor shall design, supply, install and test a manually-operated travelling crane unit in the pump control building of the Baru Pumping Station. The safe working load shall be 2000 kg.

24.7.2 Requirements

Crane Structure

The crane shall be of the single girder type. The girder shall be structurally braced to mobile blocks that travel along rails.

The girder shall be fabricated from suitably sized steel flats and stiffened internally to provide a structure of high torsional stiffness and rigidity. All assembly shall be made in jigs to ensure accurate alignment of the members. Welding shall be automatic submerged arc welding in accordance with approved welding procedures by approved welders.

Rails

Crane Rails and are included in the building works.

Supports

Supports for the crane rails and are included in the building works.

Drive Unit

The crane shall be provided with a manually operated drive unit mounted on a gear box which shall be flange mounted and spigotted to the end carriage. The output shaft of the gear box shall have high tensile pinion meshing with the spur teeth on the driven crane wheel.

Hoist Unit

The hoist unit shall comprise a manually operated chain block and a travelling trolley. Both shall be provided by an established, long-standing specialist supplier of lifting equipment and is subject to the Engineer's approval.

Surface protection of metal components shall be in accordance with clause TS 24.1.16.

24.7.3 Installation and Testing

Installation and testing shall be in accordance with the approval manual for Inspection, Testing and Commissioning referred to in Clause TS 24.1.14.

24.8 GATE WORKS

24.8.1 General

This clause 24.8 covers the requirements of the gate and stop logs to be furnished by the Contractor at the Baru Pumping Station.

24.8.1.1 Scope of Work

The work shall include the design, material arrangement, manufacturing, testing, inspecting, painting, packing, insurance, transportation from the shop to the site (including customs clearance), storage, installation, commissioning, in-situ tests and inspections, taxes, completion and rectification of defects, and provision of warranties for a period of 2 years for all mechanical and electrical plant.

General descriptions of the gates and stop logs are as follows:

Baru Pumping Station Gate

Type: Girder Type Sluice Gate with fixed rollers

Quantity: 1 (one) set

Clear Span: 4.00 m

Gate Height: 3.25

Stop Logs for Baru Pumping Station Gate

Clear Span: 4.00 m

Height: 1.50 m

Quantity: 1 set x 3 stop logs per set = 3

Stop Logs for Baru Pumping Station

Clear Span: Refer to Drawings

Height: 1.50 m

Quantity: 2 sets x 4 stop logs per set = 8

Further details are set out hereunder and in the Drawings.

24.8.1.2 Standards

The Work shall comply with the latest edition of standards and criteria listed below or such standards and criteria which are equivalent or superior to the listed ones which are accepted broadly throughout the world.

- Japanese Industrial Standards (JIS)
- Technical Standard on Dam and Weir Equipment, Japan Association of
- Dam and Weir Equipment (JADEE)
- Manual for River Works in Japan, River Bureau, Ministry of Construction, Japan

In the event that the Contractor proposes to use other standards which he claims to be equivalent or superior to the above standards he shall make application to the Engineer to use such standards and supply English versions for the Engineer's review.

24.8.1.3 Submittals

The Contractor shall submit the following documents for the Engineer's approval in accordance with the provisions of clause 1.5 of the General Specification. The following documents may be sub-sections of comprehensive manuals for the whole of the mechanical and electrical works where appropriate.

Document List

The document list shall include all documents pertaining to the gates for the Simongan Weir and adjacent off-take structures to be submitted in accordance with the General Specification and the further requirements described in this section of the specification.

Design Computations

The Contractor shall submit comprehensive design computations for the Engineer's approval in accordance with clause TS 24.1.8.

Drawings

The Contractor shall submit shop Drawings in accordance with clause TS 24.1.8.

Materials List

Detailed, tabulated materials lists showing technical details of material shall be prepared and submitted for approval.

Welding Manual

The welding as referred to in clause TS 24.1.15

Painting Manual

A painting manual as referred to in clause TS 24.1.16

Detailed Program

The detailed programme shall show details of fabrication, installation and key dates for inspections etc. The programme shall be integrated with and

consistent with the overall construction programme described in clause 1.5 of the General Specification.

Inspection, Testing and Commissioning Manual

Further to the requirements satiated in clause TS 24.1.14.1 the manual shall include details of all tests and inspections to be performed throughout all stages of procurement, manufacturing, assembly and commissioning of the gates and related systems. It shall also include dates and locations of all inspections to be performed.

Operation and Maintenance Manual

The Contractor shall prepare and submit an operation and maintenance manual for the guidance of operators and maintenance personnel in accordance with the requirements of clause TS 24.1.11.

Reports of Tests and Inspections

Reports of all tests and inspections shall be submitted to the Engineer for approval within 3 days of any test or inspection being carried out.

24.8.1.4 Materials

All materials shall be new and of first class quality conforming to the requirements of JIS or approved equal, and be suitable for the purpose, free from defects and imperfections, and of the classifications and grades listed herein, or their equivalents and shall be subject to the approval of the Engineer.

Material to be used:

- (a) Material of gate leaf
Material shall comply with "Technical Standard on Dam and Weir Equipment " or equivalent or better standards.
- (b) Welding material
Welding material shall be in accordance with the approved welding manual referred to in clause TS 24.1.15.
- (c) Sealing material
Material shall comply with the "Technical Standard on Dam and Weir Equipment " or equivalent.
- (d) Bolts, Nuts and Washers
Bolts, nuts and washers used for bolted connections shall be those specified in ISO or equivalent or better standard.

24.8.2 Design Criteria

24.8.2.1 Design Stresses

- (1) Allowable Stress of Materials
Allowable stresses shall comply with "Technical Standard on Dam and Weir Equipment (JADEE) Chapter 2", or equivalent standard approved by the Engineer.
- (2) Increase in Allowable Stress during earthquake
This item shall comply with "Technical Standard on Dam and Weir Equipment (JADEE) Chapter 2", or equivalent or better standards.

24.8.2.2 Design Data

(1) Design Loads

The basic design loads considered in the structural design of gates are self-weight of gate, static water pressure, dynamic water pressure, muddy soil pressure, seismic inertia force, wind load, wave load, thermal force and operating load. These load shall be calculated in compliance with "Technical Standard on Dam and Weir Equipment (JADEE) Chapter 2" or equivalent or better standard.

(2) Material of Main Structural Members

The quality of the material shall be of SS400, SM400, SUS304, SC450 and S25C under JIS or equivalents as approved by the Engineer.

(3) Minimum Thickness

All gate components : not less than 6 mm (including corrosion allowance)

(4) Corrosion Allowance

Corrosion allowance shall be 3 mm.

24.8.2.3 Summary of Design Criteria for Gates and Stop Logs

The Contractor shall design the gates and stop logs for the conditions summarised in the following table

Baru Pumping Station Gate

Type	Girder-type roller sluice gate
Quantity	1
Clear Span	4.00 m
Gate Height	3.25 m
HWL	EL. + 0.35
Sill Elevation	EL. -2.40
Design Head	2.75 m
Sealing Method	Rubber seal on 3 edges on upstream side
Seismic Coefficient (Kh)	0.11
Seismic Wave	0.1 m
Maximum Deflection of Beam	1/800
Corrosion Allowance	3 mm
Type of Hoist	Electrically driven wire rope wound type stationary hoist (1 motor driving 2 drums)
Operation Speed	0.3 m / minute + or - 10%
Hoisting Height	5.0 m
Operation Method	Local

Stop Logs for Baru Pumping Station Gate

Type	Steel Stop Log
Quantity	1 sets x 3 stop logs per set = 3
Clear Span	4.00 m
Stop Log Height	1.50 m
HWL	EL. + 0.35
Sill Elevation	EL. -2.40
Design Head	2.75 m (Note design head for Baru Pumping Station is to be used for all stop log design)
Sealing Method	Rubber seal on 3 edges on upstream side
Seismic Coefficient	0.11
Seismic Wave	0.1 m
Maximum Deflection of Beam	1/800
Corrosion Allowance	3 mm

Stop Logs for Baru Pumping Station

Type	Steel Stop Log
Quantity	2 sets x 4 stop logs per set = 12
Clear Span	4.00 m
Stop Log Height	1.50 m
HWL	EL. + 0.35
Sill Elevation	EL. -3.70
Design Head	4.15 m
Sealing Method	Rubber seal on 3 edges on upstream side
Seismic Coefficient	0.11
Seismic Wave	0.1 m
Maximum Deflection of Beam	1/800
Corrosion Allowance	3 mm

24.8.2.4 Design Particulars

(1) General

- (a) The gate leaves, guide frames and gate hoists shall have necessary strength and rigidity for the conditions indicated in this specification and shall have adequate safety factors against vibration and buckling.
- (b) The gate leaves and guide frames shall maintain the necessary water tightness, shall be reliable in operation, and shall have suitable structures for operation and maintenance.

(2) Gate Leaves

- (a) Appropriate drain holes shall be provided to prevent rust in the main horizontal girders where entrapment of water is possible.
- (b) In providing drain holes, the diameter of holes shall be 50mm or more and the location of holes shall be selected without adversely affecting the strength of structure.
- (c) The skin plate shall be fabricated with main horizontal girders and vertical stiffeners, and shall be welded completely all around with fillet welds to the above members.
- (d) The connections of main member shall be by welding. Where field welding is carried out it shall be performed in such a manner that welding distortion will be reduced to a minimum and deformation of and residual stress in gate leaves will not occur.
- (e) Side rollers shall be provided on each side of gate leaves.
- (f) Gate leaves shall be designed to have sufficient strength for the case of being suspended by one side only.

(3) Roller and Sheave

- a) Main rollers shall be positioned to support approximately equal loading and shall be designed and constructed not to allow excess unbalanced load.
- b) Two side rollers or more shall be provided on each side of gate.

(4) Seals

- (a) In designing seals consideration shall be given to the type of seal, the method of initial fitting and replacement. Particular attention shall be given to the water-tightness at corners. Seal shall be sufficiently strong to be resistant to stream damage when gates are partially open and they should not cause harmful vibration or cavitation.
- (b) The seal rubber shall have necessary strength, elasticity, and durability. The seal rubber also shall have necessary compression set and shall not cause excess friction nor turn up during operation
- (c) The seals shall be fixed to the gates by means of stainless steel bars and secured with stainless steel bolts and nuts at approximately 100mm centers.
- (d) Rubber seals shall be continuous to the extent possible and

shall contain as few joints as possible.

(5) Gate Guide Frames

- a) The structure of the guide frames shall be designed such that they easily accommodate gate leaves and shall have sufficient strength to bear all loads imposed on them by the gates.
- b) The roller rail shall be of corrosion resistant steel with shall have a higher hardness than the roller
- c) The sealing member of the guide frames shall be provided with stainless steel bar (equivalent to SUS 304) at least 6 mm thick, and shall be flush and smooth.
- d) Blockouts in concrete to accommodate guide frames shall be accurately formed so as to avoid the need for chipping or drilling for the purpose of installing guide frames.
- e) Steel anchor bars shall be installed during the concrete construction stage of the work.

(6) Gate Hoist

(a) Actuators

The actuators shall be full weatherproof and fitted with anti-condensation treated limit switches and torque switches. Each actuator shall be adequately sized to suit the application with a time rating of 15 minutes or twice the sluice gate operating time whichever is longer.

Alternative hand operation shall be possible, and the hand wheel together with a suitable reduction gearbox for easy operation by one man. The motor drive shall be automatically disengaged during manual operations. Manual hoisting equipment shall be so designed that the maximum required operating force to be applied by an operator is 100 N (10 kgf). A ratchet or similar device shall be fitted to prevent operating handles rotating in the reverse direction should a handle be released during operation.

The actuator shall be equipped with a gate opening indicator on the control panel in pump house.

All operating stems, gears and headstocks shall be provided with adequate points for lubrication.

(b) Gears

Gears shall be made using purpose-built gear cutting machines. The meshing of the gears shall be smooth and shall operate quietly

The gear and drum shall form an integral unit with the two components connected by means of bolts in reamed holes or other suitable method.

(c) Drums

Rope drums shall be of the rope groove type. Grooves shall be smoothly machined.

The drum lengths and the number of grooves shall be such as to accommodate the full length of ropes in one layer without overlapping and have at least one groove spare when gates is

in their highest position and at least 3 dead turns of rope remaining on drums when the gates are in their lowest positions. If rope drums are of fabricated steel construction they shall be stress relieved.

(d) Wire Rope

Wire rope shall be pre-tensioned wire rope of high quality from a long-established, reputable supplier. The diameter of wire rope after pre-tensioning shall not be less than the required diameter based on design loads.

Wire rope shall be galvanized steel or made from stainless steel.

Wire rope ends shall be swaged and fitted with metal alloy sockets.

Adjusting devices shall be provided on both sides of gates at the ends of wire ropes for the adjustment of wire rope lengths.

(e) Stop-Logs

All stop logs shall be identical and interchangeable. The maximum head to which any stop log can be subjected shall be used as the basis of design.

24.8.3 Manufacturing and Materials

a) Skin Plates and Gate Frames

The skin plates shall be made from welded structural steel to form a continuous plate. Drain holes at the bottom plate of main girder and top eyebolt for use during erection shall be provided, if necessary.

b) Roller Rails for Roller Gate

The roller rails shall be smooth and plane, free from twists, warps and kinks, and shall be welded on the welding pads mounted on the pier and abutment wall. The welding pads, studs, bolts, nuts and accessories shall be carefully adjusted so that the roller rails may be installed securely in correct positions.

c) Guide frames and seals Plates

The guide frames and shall be smooth and plane, free from twists, warps and kinks. Guide frames and seal plates may be divided into pieces for easy handling and when divided, they shall be welded in the field to form the specified total length.

d) Seals

The side and bottom seals shall be <P> type and rectangular type rubber seals respectively and shall be fixed on the gates and stop logs with corrosion resistant supporting plates, bolts, nuts and washers. The seals shall be so mounted as to permit easy replacement and adjustment in the field. The seals shall not be attached to the gate assembly during fabrication except when necessary for fitting and matching, and care shall be exercised to protect all sealing parts from damage. All steel edges in contact with or which may be in contact with the seals during operation of gates shall be rounded.

e) Sill Beams

The bottom sill plates made of corrosion resistant steel shall be welded on the sill beams of structural steel and shall be straight within specified tolerances, free from twists and warps.

f) Preparation for Field Connections

Preparatory work such as cutting, sectioning and other shaping of metals to be connected in the field shall be executed in the shop. Adequate and temporarily bolted field connections shall be provided in order to hold the gate assembly rigidly and in proper alignment during installation in the field. Holes for fitted bolts of field connections shall be shop drilled undersize to permit field reaming.

24.8.4 Method of Construction

24.8.4.1 Fabrication

The gates shall be manufactured as completely welded structures. The plates for the upstream shall be cut carefully to size. The side beams and horizontal beams shall be clamped tightly to the face plate, so as to ensure that, immediately before welding, the space between plate and members shall not exceed 1 mm. Wherever members are welded to plates, welding shall be continuous on both sides, to ensure that no water or moisture can penetrate between the two parts.

Surfaces to be welded shall be free from loose rust scales, paint, and other foreign matter. All welding shall be done by the shielded electric arc method to the extent shown on the Drawings. Welding shall be shop-welding wherever possible. Welding in the field shall not be accepted, unless authorised in writing by the Engineer. All welding shall be in accordance with good welding practice, and the approved welding manual. After each pass of weld metal has been deposited, it shall be thoroughly peened to relieve shrinkage stresses and shall be brushed with wire brush to remove all slag, dirt, or flux before the succeeding bead is applied. All welds shall show uniform sections, smoothness of weld metal, feather edges without overlaps and shall be free from porosity and clinkers. Visual inspection at the edges and end of welds shall indicate good fusion with the base metal. In assembling and during welding, the component parts of built-up members shall be held in place by sufficient clamps or other adequate means to hold the parts in proper position and in close contact. All welded components shall be stress-relieved prior to machining. All welds in the gate leaves shall be inspected by radiographic or ultrasonic methods. All defective welds shall be repaired by approved procedures and reinspected. The process shall be repeated until all welds are approved by the Engineer.

Welded rods, welding positions, welding process, joint preparation, type of welding machine, weld examination by either radiographic, ultrasonic or all other applicable methods shall be approved by the Engineer prior to commencements of the work, and the results shall be recorded by the Manufacturer, and shall be submitted to the Engineer, if required.

The gates shall be furnished complete with all rubber seals, wall plates, sills, wheels, bearings, grease facilities and all fastening materials needed. The alignment of all sills, travelling profiles, etc., within the related structural recesses shall be done by the Contractor to the Engineer's approval. All parts shall be made in accordance with the shop drawings approved by the Engineer.

The gates shall be accurately constructed so that, when installed, each pair of roller wheels has a common axis, exactly horizontal and parallel to the bottom sill.

All fabrication shall be such as to ensure that the gates are free from twists, bends and other deformations, to the satisfaction of the Engineer.

All parts shall be made accurately to industrial standards to facilitate assembly, installation and repair. The Contractor shall assume responsibility for co-ordinated and adequate design, conforming to the best engineering practice for the requirements of the work under these Specifications.

All dimensions shown on the Drawings are minimum. The manufacturer shall add such increases and finishing allowances as may be necessary to ensure that no dimension will be less.

24.8.4.2 Installation

The Contractor shall install the gates and related components as shown on the approved shop drawings, including all accessories such as anchor bolts, wall plates, guide rails and sill as far as necessary. All items to be embedded in concrete shall be supported rigidly and accurately before and while concrete is being poured. All aligning, supporting, etc., shall be done by the Contractor in accordance with good practice and to the requirements of the Engineer. Base plates, wall plates, guide rails and sills shall be grouted afterwards if shown on the Drawings or if ordered by the Engineer. Grouting shall be performed by such methods as are approved by the Engineer and shall ensure a solid setting.

Upon completion all parts shall be cleaned, lubricated and otherwise serviced by the Contractor. Grease, to be approved by the Engineer, shall be thoroughly worked into the cables. All pin bearings and roller bearings shall be grease lubricated. Hard grease is to be used in bearings and seals so as to ensure the impermeability to water and moisture.

All closed gear-reducers shall be filled to the correct levels with lubricating oil of type approved by the gear-reducers manufacturer. Open gear - reducers shall have a good quality graphite-grease applied on the teeth. All lubricants and cleaning agents shall be furnished by the Contractor at no extra cost.

All gate seals are to be installed as shown on the Drawings. The side seals shall be placed so that they are in contact with the wall plates or side shields throughout their length, in such a way that they are not deformed by the pressure against the side faces. The bottom seals shall contact the sill throughout their length. The Contractor shall take special care with seal joints at the corners so as to prevent leaking at these places.

The hoists shall be placed in correct alignment with the gates. The cables of each shall be adjusted to the same tension.

All electrical works shall comply with the requirements of Section TS 25, "Electrical Works".

The use of force during assembly shall not be tolerated. Temporary construction may be fixed to the main structures only after the approval of the Engineer. If during assembly, chains or cables must be fixed to the foundations or any other part of the structures, strong and sufficient timber supports shall be used to protect the respective structures from any damage.

After cleaning and lubricating, the Contractor shall prove the proper operation of each unit by running each gate completely up and down for at

least 5 times per gate. Should any part of these works fail to operate to the satisfaction of the Engineer, such alterations shall be made by the Contractor as are required by the Engineer, without entailing extra payment thereof.

24.9 INSTALLATION AND TESTING

24.9.1 General

The Contractor shall install all equipment for each of the systems in the Baru Pumping station in accordance with the procedures approved by the Engineer and as specified hereunder.

The systems to which this clause applies are as follows:

- The main pump system
- The diesel engines for the main pumps and all auxiliary equipment
- The diesel generator system (Refer to TS 25, Electrical Works)
- The auxiliary pump system
- All electrical systems associated with the above systems
- All electrical systems shall be installed and tested in accordance with the provisions of the section TS 25, Electrical Works.

24.9.2 Installation

The Contractor shall remove the pumps, diesel engines, generator, trash screen units, conveyor, and other auxiliary equipment from their respective packing and shall inspect for damages. The Contractor shall repair or replace any damaged portion of the various plants, subject to the approval of the Engineer.

Anchor bolts shall be cast in place in accordance with templates supplied by the respective suppliers of the various items of equipment. All anchor bolts shall be of stainless steel 316. S15 to BS 970 unless otherwise approved.

The upper and lower bearings for the screw pumps shall be mounted on their respective concrete plinths and accurately aligned.

The screw pumps shall be mounted on the bearings and further checks and of correct alignment of bearings made.

Particular care shall be taken to ensure the correct alignment of the pump shafts and reduction gear boxes.

After final alignment the bearing mounting assemblies shall be grouted with non-shrink grout.

The troughs for the screw pumps shall be formed as shown in the Drawings, using the method approved by the Engineer, to the accuracy consistent with the recommendations of the pump supplier.

The bases for diesel engines, generator and other auxiliary units shall be installed on their respective concrete plinths or concrete foundations.

After final alignment, the bases shall be grouted with non-shrink grout.

All other equipment including, but not limited to, auxiliary pump system equipment, trash system components, overhead crane system components shall be similarly accurately installed and checked for correct placement, alignment in accordance with the approved drawings and installation procedures.

24.9.3 Testing

24.9.3.1 General

All testing shall be performed in accordance with the Inspection, Testing and Commissioning Manual referred to in clause TS 24.1.14 and the guidelines hereunder.

Prior to delivery to the site equipment shall be tested and inspected according to the respective manufacturers' quality control procedures. The requirements of documentation and inspection by the Engineer or his representative are described in clause TS 24.1.2

The Contractor shall test each item of equipment, each system and the overall operation of the Baru Pumping Station in accordance with the specification and the testing schedule approved by the Engineer.

Before any test is made, the Contractor shall check that every item of equipment complies with the requirement of the specification, is installed correctly, with correct alignment and with the proper connections with associated equipment, and is in satisfactory operating condition.

Each item of equipment and associated equipment shall be tested to prove that the operation is satisfactory and its performance in accordance with the specified requirements and the performance indicated in the data sheets supplied by the Contractor with his bid.

All tests to be carried out in accordance with the approved procedure shall be witnessed by the Engineer or his representative. The Contractor shall give the Engineer at least 24 hours notice of any test he intends to carry out which is required to be witnessed by the Engineer.

24.9.3.2 Tests at Site

Preliminary Tests

During and after the installation of each item of equipment, the Contractor shall perform the following preliminary tests to establish the accuracy of the assembly, to be in sound condition to operate under load and to prove the adequacy of the materials and the workmanship's. All tests and test procedures shall be approved by the Engineer.

All electrical test shall be conducted in accordance with the requirements of section TS 25, Electrical Works.

Operation tests of auxiliary equipment

Pump reduction gear and engine shaft alignment and measurement of pump flight clearances

Operation of the pumps and engines, to check bearing operation, running clearances

Any additional tests required by the Engineer to ensure the safety of the equipment when operated

Tests on Completion

After all components of each system have been installed, tested and found to be satisfactory and each system checked for satisfactory operation and all necessary adjustments made, the Contractor shall conduct operational tests in the Engineer's presence to demonstrate that the entire work has been properly installed, and is correctly adjusted to operate as specified.

The Contractor shall make all final adjustment to the control and detection devices. The Contractor shall be responsible for the operation of the system during the test on completion.

Pump operation tests shall be made when water level in the inlet channel is above levels at which the auxiliary pumps and the main pumps will operate at their respective full capacities. All tests shall be carried out by the Contractor on his responsibility and at his costs including necessary testing equipment and instruments.

Electric power, fuel and other consumables is required for any test it shall be provided by the Contractor at his own expense. The final results of all tests including tests run by the Contractor shall be subject to acceptance by the Engineer.

Unless otherwise specified, the Contractor shall submit to the Engineer five (5) copies of all test or inspection reports.

Extended Testing

For the purposes of verifying proper equipment operating procedures testing shall continue until the end of the wet season following Completion. The Contractor's obligation during this period, in addition to his obligations regarding Defects Liability and Warranties, shall be to provide all consumables for the complete operation of the pumping station and gates. Compliance with this requirement shall not prejudice the rights and entitlements of the Contractor in relation to Completion.

24.10 MEASUREMENT AND PAYMENT

This clause specifies the method of measurement and payment for the mechanical works portion of the Works.

24.10.1 Main Pump System

Main Pumps

This clause covers the main pump system specified in clause TS 24.2.

Payment for main drainage pumps shall be made at the price per set entered in the priced Bill of Quantities.

Payment shall be made in the following manner:

- For the purpose of interim payment, sixty (60) percent of the price per set shall be paid in the form of a monthly progress payment upon arrival of each pump at the Site and upon submission of the following documents:
- Inspection certificate issued by the Engineer.
- The remaining forty (40) percent of the price per set, which is deemed as the cost for installation, supervision, operational test, training of local staff for the pump operation and maintenance, shall be following the completion of testing of the entire system for the Baru Pumping station to the Engineer's approval.
- Payment shall constitute full compensation for designing, manufacturing, delivering, installing, commissioning, supervising, testing and training of local staff for the pumping facilities operation, and all other associated costs.

Gear Boxes

Payment for gear boxes shall be made at the price per set entered in the priced Bill of Quantities.

Payment shall be made in the following manner:

- For the purpose of interim payment, sixty (60) percent of the price per set shall be paid in the form of a monthly progress payment upon arrival of each pump at the Site and upon submission of the following documents:
- Inspection certificate issued by the Engineer.
- The remaining forty (40) percent of the price per set, which is deemed as the cost for installation, supervision, operational test, training of local staff for the pump operation and maintenance, shall be following the completion of testing of the entire system for the Baru Pumping station to the Engineer's approval.
- Payment shall constitute full compensation for designing, manufacturing, delivering, installing, commissioning, supervising, testing and training of local staff for the pumping facilities operation, and all other associated costs.

The items to be paid under this clause is as follows:

Pay Item No.	Description	Unit of Measurement
C.3.1	Furnishing and Installing Main Pump Units	set
C.3.2	Gear Boxes	set

24.10.2 Diesel Engines for Main Pumps

This clause covers the method of payment for the diesel engines for the main pumps as specified in clause TS 24.3

Payment for diesel engines for the main pumps shall be made at the price per set entered in the priced Bill of Quantities.

Payment shall be made in the following manner:

- For the purpose of interim payment, sixty (60) percent of the price per set shall be paid in the form of a monthly progress payment upon arrival of each pump at the Site and upon submission of the following documents:
- Inspection certificate issued by the Engineer.
- The remaining forty (40) percent of the price per set, which is deemed as the cost for installation, supervision, operational test, training of local staff for the pump operation and maintenance, shall be following the completion of testing of the entire system for the Baru Pumping station to the Engineer's approval.
- Payment shall constitute full compensation for manufacturing, delivering, installing, commissioning, supervising, testing and training of local staff for the pumping facilities operation, and all other associated costs.

The item to be paid under this clause is as follows:

Pay Item No.	Description	Unit of Measurement
C.3.3	Diesel Engine Units	set

24.10.3 Auxiliary Equipment for Diesel Engines

This clause covers the method of payment for auxiliary equipment for diesel engines as specified in clause TS 24.4

Payment for auxiliary equipment for diesel engines comprising Fuel Transfer Pump, Fuel Storage Tank and Fuel Service Tank shall be made at the respective prices per set or lump sum price entered in the priced Bill of Quantities.

Payment shall be made in the following manner:

- For the purpose of interim payment, eighty (80) percent of the price shall be paid in the form of a monthly progress payment upon arrival of each unit at the Site and following the issuance of an inspection certificate by the Engineer.
- The remaining twenty (20) percent of respective prices, which is deemed as the cost for installation, supervision, operational test, training of local staff for the pump operation and maintenance, shall be made following the completion of testing of the entire system for the Baru Pumping station to the Engineer's approval.
- Payment shall constitute full compensation for manufacturing, delivering, installing, commissioning, supervising, testing and training of local staff for the pumping facilities operation, and all other associated costs.

Items to be paid under this clause are as follows:

Pay Item No.	Description	Unit of Measurement
C.3.4	Fuel Service Tank	set
C.3.5	Fuel Transfer Pump	set
C.6.6	Fuel Tank and Accessories	L.S.
C.6.7	Grounding (for fuel tank)	L.S.

24.10.4 Piping Systems

This clause covers the method of payment for auxiliary equipment for diesel engines as specified in clause TS 24.5.

Discharge Piping for Auxiliary Pumping System

No separate payment shall be made for this item and the cost of piping shall be included in the price for the auxiliary drainage pump system.

Fuel Supply Piping System

Payment shall be made at the Lump sum price stated in the Bill of Quantities for the completed fuel supply piping system, in place and approved by the Engineer.

Payment shall constitute full compensation for supplying, installing, commissioning, supervising, testing and commissioning of all piping, valves and other piping system components up to the flanges of the various tanks and equipment served by the piping system. The vent pipe for the fuel tank is also included in this item. The price shall also include allowance for training of local staff for the pumping facilities operation, and all other associated costs.

The item to be paid under this clause is as follows:

Pay Item No.	Description	Unit of Measurement
C.3.8	Piping System	L.S.

24.10.5 Auxiliary Drainage Pump System

This clause covers the method of payment for the auxiliary drainage system specified in clause TS 24.6.

Payment shall be made at the lump sum price entered in the priced Bill of Quantities for the Auxiliary Drainage Pump System, in place and approved by the Engineer.

Payment shall constitute full compensation for manufacturing, delivering, installing, commissioning, supervising, testing of the complete auxiliary drainage pump system, including all associated piping, and for training of local staff for the pumping facilities operation, and all other associated costs.

The item to be paid under this clause is as follows:

Pay Item No.	Description	Unit of Measurement
C.3.6	Auxiliary Drainage Pump System	L.S.

24.10.6 Overhead Crane

This clause covers the method of payment for the overhead crane system specified in clause TS 24.7

Payment shall be made at the price for the complete set as entered in the priced Bill of Quantities for the Overhead Crane, in place and approved by the Engineer.

Payment shall constitute full compensation for designing, manufacturing, delivering, installing, commissioning, supervising, testing of the complete crane system (excluding the rails which are included in payment for building works), and for training of local staff in the use of the crane, and all other associated costs.

The item to be paid under this clause is as follows:

Pay Item No.	Description	Unit of Measurement
C.3.7	Overhead Crane	set

24.10.7 Gate Works

This clause covers the method of payment for the gate works specified in clause TS 24.8

Gate Leaf Guide Frame and Hoist

Payment for gate leaf, guide frame and hoist shall be made at the respective prices per set entered in the priced Bill of Quantities.

Payment shall be made in the following manner:

For Gate Leaf and Hoist:

- For the purpose of interim payment, sixty (60) percent of the price shall be paid in the form of a monthly progress payment upon arrival of each complete set at the Site and following the issuance of an inspection certificate by the Engineer.
- The remaining twenty (40) percent of respective prices, which are deemed as the cost for installation, supervision, operational test, training of local staff for the gate operation and maintenance, shall be made following the completion of testing of the complete gate system to the Engineer's approval.

For Guide Frame:

- Payment shall be made following completion and completion and testing of the gate system to the Engineer's approval.
- Payment shall constitute full compensation for designing, fabricating, delivering, installing, supervising, testing and training of local staff for in gate operation and maintenance and for all other associated costs.

Stop Logs

Payment shall be made at the Lump sum price entered in the priced Bill of Quantities for stop logs.

Payment shall constitute full compensation for designing, supplying, installing, testing, removal and stacking in a nominated place in the pumping station complex of stop logs and the related spreader beam.

Items to be paid under this clause are as follows:

Pay Item No.	Description	Unit of Measurement
D.2.1	Gate Leaf	set
D.2.2	Guide Frame	set
D.2.3	Hoist	set
D.2.4	Stop Log	L.S.

24.10.8 Inspection and Test

This clause covers the method of payment for the inspection and testing of all mechanical works as specified in clause TS 24.1.14.

Payment shall be made at the lump sum price entered in the priced Bill of Quantities following completion of all inspection and testing to the approval of the Engineer.

Payment shall constitute full compensation for supplying the tools, specialised equipment, specialised personnel, the cost of expenses for the Engineer or his Representative to attend specified workshop test, the cost of all consumables for the Extended Testing and any associated costs.

Interim payment shall be made in accordance with inspections completed and shall be based on the Contractor's breakdown of the lump sum price.

The item to be paid under this clause is as follows:

Pay Item No.	Description	Unit of Measurement
C.3.9	Inspection and Test	L.S.

24.10.9 Maintenance Tools and Spares

This clause covers the method of payment for the furnishing of maintenance tools and spare parts specified in clause TS 24.1.9 and TS 24.1.8 respectively.

Payment shall be made at the lump sum prices as entered in the priced Bill of Quantities the following delivery to the Site of complete sets of spares and tools (complete with tool boxes for each set of tools) in accordance with the schedules of spare parts and maintenance tools for each system, as entered in the data sheets appended to the Contractor's bid.

Payment shall constitute full compensation for supplying the tools and spares as specified, and any associated costs.

Items to be paid under this clause are as follows:

Pay Item No.	Description	Unit of Measurement
D.2.5	Spare Parts (for gate)	L.S.
C.3.10	Spare Parts	L.S.
C.3.11	Maintenance Tools	L.S.

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SECTION TS 25 . ELECTRICAL WORKS

25.1 GENERAL REQUIREMENTS

25.1.1 General

This section of the Technical Specification covers the general and specific requirements for electrical works for the Baru Pumping Station and Baru Gate and all electrical works associated with the mechanical works for the Baru Pumping Station and Baru Gate described in Section TS 24 which shall be read in conjunction with this section.

Unless otherwise specified, electrical works for Building Works, as defined in Clause 27.2 of TS 27, shall comply with the technical specification for electrical works appended to section TS 27.

The general requirements in clause TS 25.1 shall apply to all electrical works to be performed under the Contract including electrical works associated with the above-mentioned mechanical works.

25.1.2 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)

25.1.3 Data Sheets

The completed data sheets E1 to E 7 shall form part of, and shall be read in conjunction with, this section of the Technical Specification.

25.1.4 Warranties

The Contractor shall provide warranties guaranteeing the plant supplied under the Contract from the manufacturers/suppliers of all electrical plant. Such warranties shall have a minimum duration of 2 years from the Completion Date and shall be made out in favour of the Employer. The warranties shall be consistent with the information provided by the Contractor in the approved data sheets forming part of the Contract.

25.1.5 Spare Parts

The Contractor shall supply spare parts for maintenance purposes suitable for 5-years operation, in accordance with the approved schedule, based on the accepted recommendations of the Contractor made in completed data sheets appended to his bid for all electrical plant provide under the Contract.

25.1.6 Maintenance Tools

The Contractor shall supply tools for maintenance purposes suitable for 5-years operation, in accordance with the approved schedule, based on the accepted recommendations of the Contractor made in completed data sheets appended to his bid.

25.1.7 Qualifications

All specialist sub-contractors performing work under the Contract shall meet the following criteria:

- They shall be companies which have regularly provided the similar type of works to that required for not less than 5
- Their workmen shall be well trained and experienced in the type of works required.

All specialist suppliers of equipment shall meet the following criteria:

- They shall have been regularly producing systems of types required for not less than 5 years before the date of submission of Bid.
- They shall be capable of providing immediate emergency service within three (3) days after notification by Employer.
- They shall be capable of entering into full service maintenance agreement with Employer after the expiration of warranties.
- Their workmen shall be well trained and experienced in type of works required and in direct employ of the manufacturer.
- They shall issue warranties for all plant supplied by them in accordance with the requirements of the Contract.

25.1.8 Codes, Inspections, Permits and Fees

The works under this Contract is to be installed according to the requirements of the latest Indonesian codes for electrical works, and the applicable ordinance and requirements of the power authority (PLN). 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.

25.1.9 As-Built Drawings

As-built Drawings shall be prepared by the Contractor in accordance with clause 1.4.4 of the General Specification

25.1.10 Shop Drawings and Samples

Shop Drawings and samples shall be submitted by the Contractor in accordance with requirements of clause 1.4.4. of the General Specification.

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.

25.1.11 Minor Modifications

The plant and equipment layout as drawn is based upon preliminary drawings and details and show conditions as accurately as possible. They are diagrammatic and do not necessarily show all fittings, etc., necessary to fit actual conditions. The locations of outlets, apparatus and appliance shown on the plans therefore are approximate. The Contractor shall, in consultation with the Engineer, be responsible for the detailing and proper location to make fit with architectural details and provide all necessary fittings and appurtenances as may be required by the Engineer at no extra cost. The Contractor shall be responsible for verifying the actual location of all items.

25.1.12 Approvals and Substitutions

Wherever hereinafter the words "for approval", or "approved" (make, type, size, arrangement, etc.) are used, especially with regard to manufactured specialised equipment, 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.

25.1.13 Subcontractors

The Contractor shall be held fully responsible for the work of any subcontractors performing work or for 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.

25.1.14 Workmanship

The work throughout shall be executed in the best and most thorough 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.

25.1.15 Standards of Materials

All materials shall be new and shall conform with the standards listed in clause 25.1.2 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.

25.1.16 Approval of Materials

All 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 Letter of Acceptance, 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, Drawings or samples which he proposed to use or install.

25.1.17 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.

25.1.18 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.

25.1.19 Related Documents

General:

Materials and equipment shall not be ordered or fabricated until submittals have been approved.

Shop-Drawings:

Shop Drawings shall be completed in accordance with the requirements of clause 1.4 of the General Specification and shall indicate the following:

- Complete dimensional data.
- Elevation views for complete representation.
- Construction details for anchorages to structures.
- Arrangement of devices and appurtenances.
- Waterproofing details for exterior and underground works and penetrations.
- Location and size of connections.
- Identification schedules.
- Substituted equipment or materials requiring changes in sizes, connections, arrangements, installations or wiring.
- Wiring diagrams as specified elsewhere herein for work and systems as proposed.
- Manufacturer's certified drawings for all major equipment items.
- Detail wiring plans for all electrical systems.

- **Material/Colour Samples:** Provide for primary materials or finishes or other components and when requested by the Engineer.

Certification of Materials:

Certificates shall be obtained 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.

25.1.20 Supervision of Electrical Works

General Electrical Works: Contractor shall furnish full-time services of one or more experienced professional electrical engineers well qualified in directing and overseeing all phases of works of type required.

The Contractor shall provide the services of manufacturers' specialised engineers in full-time service as necessary to supervise equipment installation and for the execution of testing and commissioning specialised equipment supplied.

Supervisory Personnel: The Contractor shall maintain the supervisory personnel at the Site, 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.

Retaining or arranging for manufacturer's representative shall not be construed as waiver of responsibilities of the Contractor under the terms of the Contract.

25.1.21 Product Requirements

Electrical Materials, Assemblies and System unless or except as otherwise shown, specified or approved, shall conform to the followings:

Manufacturer's first quality line of standard and/or series or factory fabricated items as shown in the Drawings or specified.

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.

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.

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 same manufacturer.

Where a device, part of piece of equipment is referred to in singular number, such reference shall apply to all services or parts required to complete the works.

Electrical parts and components identical throughout each electrical system shall be readily interchangeable.

25.1.22 Equipment Work Requirements

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.

Each system of equipment shall be designed, fabricated, and furnished by a single manufacturer.

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.

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.

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.

25.1.23 Execution Requirements

Prior to commencing electrical works the Contractor shall review details of electrical works with the Engineer, incorporating adjustments deemed necessary and as directed.

For interior works, building shall be adequately closed and/or protected.

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.

Works shall not proceed until the Contractor has verified the following:

- Supporting construction to be in proper condition and any improper construction conditions have been corrected, re-inspected and approved.
- Layouts, locations and tolerances are correct for this Work.
- Respective areas receiving works have been inspected and approved by the Engineer.

25.1.24 Completion Requirements

General:

Remove waste and debris resulting from this works; as work progresses and upon completion.

Service and adjust moving or mechanical parts for smooth, quiet and proper operating condition.

Touch-up abraded or damaged painting or galvanizing.

When Completed:

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.

Installation shall be free from exposed fastening, unnecessary cuts, holes, blank plates, advertising labels or signs; other than as particularly specified or approved.

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.

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.

Each item, unit or assembly shall be tightly and rigidly secured in place free from unnecessary movement, squeak or rattle.

Each item, unit or assembly shall be set straight, plumb and level; accurately positioned at locations required; adjacent similar units shall be accurately aligned.

Movable mechanical items or devices shall be serviced and adjusted to operate smoothly, quietly, easily and without binding.

Mechanical assemblies or system shall be serviced and adjusted to operate in compliance with performance requirements shown or specified, and tested as specified.

Electrical devices, assemblies or systems shall be properly connected and grounded, operating in compliance with performance requirements shown or specified, and tested as specified.

25.1.25 Servicing Requirements

Lubrication:

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.

Include all necessary grease fittings, oiling caps or other like facilities as required to maintain equipment properly protected. The same lubrication system should be used for items of similar equipment.

Locate lubrication facilities where they are readily visible and positioned where easily accessible.

Service Tools:

Two complete sets as required for each equipment, item or system or work.

Tools shall include all necessary lubricating tools and supplies and any specialised hand tools necessary for operation, adjustments or regular up-keep service.

Each set shall be contained in a suitable metal box or panel. The outside of the tool container shall be clearly identify the respective equipment for which the tools are required.

25.1.26 Maintenance Services

The Contractor shall furnish maintenance and call-back service for all electrical systems after completion and placed in operation for the duration of the two-year warranty period applicable to all mechanical equipment.

The maintenance services shall consist of examinations of equipment, adjustments, lubrication, cleaning, provision of supplies and parts to keep the equipment in proper operation.

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 subject to his prior consent.

All works will be done by trained employees of the Contractor or manufacturer during regular working hours of the trade.

Emergency services shall be available when called for, at additional cost to Employer except where cause are attributable to Contractor or manufacturer.

25.1.27 Certification of Installation

Certification of the installation is required for all general equipment work and systems.

It shall be prepared by the Contractor or by independent testing agencies regularly providing test and inspection type works required and as retained by the Contractor.

25.1.28 Maintenance Instructions

Maintenance instructions are required for each of the various electrical systems.

They shall 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.

25.1.29 Operating Instructions

The Contractor shall provide operating instructions for general use and operation of various items of equipment and systems.

Each set of instructions shall be specifically prepared for equipment or systems as installed.

25.1.30 Service Manuals

The Contractor shall provide Basic Service Manuals: These shall be provided as part of initial submittals and shall include:

- Complete list of spare parts and current price lists thereof.
- List of especially critical parts recommended by manufacturer which are being supplied by the Contractor under the Contract.

The Contractor shall provide Complete Service Manuals which shall include the following :

- All data as required for Basic Service Manuals.
- Other data as may be particularly required.
- Wiring diagrams for Works as installed.
- Complete Equipment Identification Schedule for Work as installed.

25.1.31 Equipment Identification Signs

Equipment identification signs are to be provided for each item of electrical equipment item in readily visible locations. Each sign shall be installed level and symmetrically positioned. Signs shall be prepared in accordance with the following:

Sign Description:

Size: Suitable for size of equipment upon which sign is mounted.

Type: Laminated bakelite with engraved letters or other standard with equipment manufacturer as approved by the Engineer.

Colours: Black plaque, white letters, unless otherwise directed or approved by the Engineer.

Letters: Plain block or gothic style only.

Designation

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.

Named acrylic or metal plates shall be posted near meters, relays, switches on the front surfaces of all panelboards.

Pilot lamps and indication lamps on front surface of all panelboards shall be etched and imprinted.

Acrylic resin name plates shall be posted on circuit breakers, relays, connection terminals and other parts in all panelboards.

Identify individually:

Each motor control centre and control panels.

Each panelboard.

Each disconnect switch or circuit breaker regardless if whether separately mounted or grouped with others in a single housing.

Each wire or cable in each secondary feeder

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.

The nomenclature used to identify switchboards and panelboards shall designate the numbers assigned to them.

The nomenclature used to identify switches or circuit breakers shall:

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.

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

25.1.32 Manufacturer's Identification

Manufacturer's identification is required for each factory fabricated fixture or equipment item. It shall be applied on items to be concealed when installed and normally closed, shall be readily visible and readable when opened.

Such labels or nameplates must be those standard with manufacture, shall be non-corrosive and durable, and permanently attached.

Labels or nameplates shall state fixture or equipment item type, model, number, rating, current characteristics etc.

25.1.33 Circuit Directories

Current directories are required for each panel containing electrical control or safety devices and shall be installed at the back of panel doors.

Each directory correlated with panel as arranged and installed and in type-written form only.

Each directory shall be protected and retained by suitable frame and clear glass or plastic cover.

25.1.34 Keyed Locks and Switches

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.

The Contractor shall submit proposals for keying for the Engineer's approval.

Keys Required:

Master keys and change keys: not less than 6 each shall be provided.

Duplicate sets of all keys shall be provided by the Contractor.

25.1.35 Attachment to Structures

General:

Types of attachments shall be appropriate for materials and conditions encountered and only as shown, specified or approved.

Sizes shall be adequate for loads and forces involved.

Cutting or welding to structure for support shall be permitted only as and where specified or approved by Engineer for each specified condition or location.

Supporting piping or equipment by attachments directly to metal decking shall not be permitted.

Steel items shall be hot-dip galvanised or painted in accordance with the specification for protective treatment of metalwork in Section TS 24 of the Technical Specification.

Continuous Supports:

Continuous supports shall be of the manufacturer's standard prefabricated type of C-Channel and shall be roll-formed from steel strip thickness not less than 2.5 mm and in standard length units requiring a minimum number of splices.

Continuous supports shall be complete with matching splices covers, insert devices suitable for hanger rods, etc. required to be supported.

They shall be secured to overhead concrete using unit anchors set through pre-punched holes in C-Channel webs.

Unit Anchors:

Unit anchors shall be 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.

Each unit selected shall be in accordance with manufacturer's certified load carrying capacity tables, as approved.

Each unit shall be selected to safely support works required and when under full load conditions; and as appropriate to which attachment is being made.

Selection of anchors shall be made using Factor of Safety not less than 5 times the loads to be supported.

In any and all cases, bolt shank diameter shall be not less than 15 mm.

Other Consideration:

Heavy Items in Steel Framing shall be attached using machine bolts, nuts and washers set through drilled holes.

Light Items to Steel Framing shall be attached using machine screws set into drilled and tapped holes or set through drilled holes and with nuts and washers.

Light Items in Sheet Metal shall be attached with self tapping screws.

Wood, fibre, plastic or lead type inserts shall not be used.

25.1.36 Protective Coating

General

Protective coatings are required for materials and equipment not otherwise pre-finished, protected or included for field painting.

Painting work and materials required herein and not otherwise specified shall be in accordance with applicable requirements specified under clause TS 24.1.16.

Includes all locations, whether exposed or concealed in completed work.

Painting

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.

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.

Metalwork which is normally painted on Site shall be prepared as aforesaid and given one coat of approved preservative paint before leaving the factory.

Metalwork which will be erected in the open shall be given top coats of bitumen based paint with appropriate approved primer and undercoat.

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.

The inside of control cubicles, cabinets, etc. where condensation is liable to occur shall be coated with approved anti-condensation composition.

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 necessary.

25.1.37 Safety Equipment and Notices

Copies of all statutory safety notices, regulations and instructions for resuscitation and treatment after electrical work shall be prominently displayed. Such notices shall be treated with clear varnish and mounted in a suitable frame.

Danger signs on the motor centres/control panels shall be provided.

The Contractor shall provide 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.

25.2 POWER INTAKE CABLE WORKS

25.2.1 Description of Works

This clause 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 [kWh Meter & Distribution Panel] installed in the pump control building, and grounding rods.

25.2.2 Materials

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

Cable

Cable shall be 600 V Class XLPE (Cross-linked Polyethylene insulated and PVC sheathed) cable.

Conduit

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

25.2.3 Installation

Conduit

Underground conduit shall be installed to 600 mm in depth and excavation and back filling shall conform to the requirements of Section TS 2.1 Earth Works of the Technical Specification.

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.

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.

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 mm².

25.3 MAIN CONTROL PANEL

25.3.1 Description of Works

The works comprises the supply, installation, testing and commissioning of indoor use metallic panels in accordance with the drawings, the specifications and the instruction of the Engineer.

25.3.2 Main Control Panel

25.3.2.1 Composition

The Main Control Panel shall consist of the following sections.

- kWh METER & DISTRIBUTION PANELS
- MOTOR CONTROL PANEL
- WATER LEVEL INDICATION AND ALARM PANEL
- BATTERY AND CHARGER PANEL

The panels shall be fabricated as one unit with modules having similar dimensions, finish and configuration.

All panels shall be provided with both of front and rear access doors.

25.3.2.2 Enclosure

The enclosure shall be made of sheet steel of minimum thickness as follows.

- For enclosure: 2.0 mm
- For interior partitions: 1.6 mm
- Index of Protection of all enclosures shall be IP 52.

All enclosures shall be strongly built, specifically designed to enclose equipment scheduled or shown, and able to 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 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.

All doors shall be fully openable for ease of installing or removing equipment or devices.

Ventilation openings shall be provided to required panels.

All enclosures shall be connected to the grounding rod by PVC-insulated wire of 25 mm².

25.3.2.3 Circuit Breakers

The circuit breakers installed to the Main Control Panel shall be 600 V Class MCCB (Moulded Case Circuit Breaker) rated as shown on the drawings.

25.3.2.4 Batteries Charger

Batteries charger to be used shall re-charge the diesel engine start batteries within 5 hours.

25.3.2.5 Water Level Detector

The type and requirements for water level detector shall be as follows:

- a. Type: float switch
- b. Water level of measurements: 4-Points or -3.00 m, -2.50 m, -1.50 m and -1.00m
- c. Trash and wave protector: Shall be required
- d. Cable connection box with connection terminal block: Shall be required

25.3.3 Installation

The bank of Main 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.

25.4 GENERATOR SYSTEM

25.4.1 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.

25.4.2 Qualifications of Manufacturer / Subcontractor

The manufacturer of the generator system and the subcontractor responsible for its installation shall have had the levels of experience stated in clause TS 25.1.7.

25.4.3 Shop Drawings and Calculations

The Contractor shall submit the following in accordance with the procedures in clauses 1.4 and 1.5 of the General Specification:

- 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.
- General requirement drawings showing location of all auxiliary equipment in relation to the diesel generating unit.
- Piping schematics for fuel oil, lubricating oil, integral with diesel engines
- Critical speed calculations.
- Electrical elements, schematics and wiring diagrams, including details of the safety shutdown systems and main generator circuit breaker trip system.

25.4.4 Certified Test Reports

The following tests shall be carried. Certified test reports shall be prepared and submitted to the Engineer for approval.

- Diesel engine shop tests
- Generator shop tests.
- Diesel engine driven electric generator set shop tests.

25.4.5 Products

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 those 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.

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.

25.4.6 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 of operation.

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

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.

Critical Speeds

The complete diesel 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^2 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.

25.4.7 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.

25.4.8 Generator Diesel Engine and Accessories

25.4.8.1 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 a 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
Rating	3-Phase, 380 V, 50 Hz, 30 kVA
1 Hour rating output	Not less than 110% of Rating Capacity
Continuous operating speed: (rpm)	3,000
Bore of Cylinders: (mm)	
Number of Cylinders:	
Specific fuel Consumption	
Starting System:	Battery, 100 Ah, DC 12V
Location of Operation:	Baru Pump House
Engine cooling system:	Radiator
Engine Lubrication System:	Forced lubrication by use of gear pump mounted on engine
Fuel Oil Recommended:	Diesel heavy oil

Note: Blank items shall be in accordance with the completed, approved, data sheets submitted by the Contractor with his bid.

25.4.8.2 Manufacturing and Materials

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.

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.

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.

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.

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.

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.

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.

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).

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.

25.4.8.3 Accessories

The diesel engine shall be complete with the following accessories:

Gauges

Tachometer, lubrication oil pressure, , etc.

Thermometer

Lubrication oil, cooling water, etc.

Auxiliary Priming Pump

Wing type lubrication oil pump.

Strainer and Cooler

Fuel oil strainer, lubrication oil strainer, lubrication oil cooler, suction air cooler, etc.

Safety Devices

Lubrication oil pressure relay, cooling water high temperature relay, over speed relay, cooling water flow - sight glass, etc.

Miscellaneous

Exhaust system shall have a turbo-supercharger, pressure indicator cock for each cylinder, flywheel and dual air reservoir tanks, flexible pipe joints, installation bolts, etc.

25.4.9 Diesel Generator and Excitation Systems

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.

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.

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.

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.

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 $\frac{1}{4}$ 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.

Voltage adjusting rheostat

Manual voltage control with adjusting rheostat

Engine - Generator Instruments and Controls

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

Generator Controls and Instruments

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

- 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.
- Frequency Meter: Dial type.
- Control Switches: Voltage and ampere ratings suitable for the intended use. Contacts shall be rated in accordance with NEMA Standards ICS 2 -125.
- 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.
- Voltage adjustment rheostat.
- Panel lights and control switch.
- Alarm indicating panel.

25.4.10 Base Assembly and Enclosure

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.

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.

25.4.11 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.

25.4.12 Execution

25.4.12.1 Installation

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

25.4.12.2 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.

25.4.12.3 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.

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.

Speed Governing Test

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

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:

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

25.5 POWER SUPPLY WORKS TO EQUIPMENT

25.5.1 Description of works

This clause covers the technical requirements for the equipment, materials, workmanship, fabrication and installation of power supply works to include but not limited to, all cabling works between the distribution panel installed in the pump building and each control panel of the equipment listed hereinafter, and control panels.

The following power feeders and branch cables are included in the scope of work described in this clause:

- Feeder to Auxiliary drainage Pumps
- Feeder to Gate Lifts
- Branch Cable to Grease Pump 1
- Branch Cable to Grease Pump 2
- Branch Cable to Grease Pump 3
- Branch Cable to Fuel Transfer Pump
- Branch Cable to Gate Lift Motor

25.5.2 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.

25.5.2.1 Cable

Cable shall be 600 V Class XLPE (Cross-linked Polyethylene insulated and PVC sheathed) cable.

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

25.5.2.2 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 and uniform in cross-section.

25.5.2.3 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.

25.5.3 Installation

25.5.3.1 Conduits

The conduit runs for the branch cables to the grease pumps shall be embed into the floor slab of the building and all other conduit runs shall be installed to the exposed location.

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.

25.5.3.2 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.

25.5.3.3 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.

25.5.3.4 Control Panels

All 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.

25.6 LOCAL SWITCH FOR FUEL TRANSFER PUMP

The switch shall consist of one Moulded Case Circuit Breaker, voltage indication lamp, magnetic switch and manual operation (ON/OFF) switch.

These components shall be installed in a metallic enclosure of protection grade IP 65.

25.7 LOCAL CONTROL PANELS

25.7.1 Scope

This clause covers the requirements for local control panels for the auxiliary pump system and for the local control panel for the gate.

25.7.2 Enclosures

The enclosures of panels shall be made of sheet steel of minimum thicknesses as follows:

- For enclosure: 2.0 mm
- For interior partitions: 1.6 mm
- The Index of Protection of each control panel shall be as follows:
- For auxiliary pump control panel: IP 65
- For gate control panel: IP 52
- All enclosures shall be strongly built specifically designed to enclose equipment scheduled or shown on the Drawings and shall be capable of withstanding vibration or shock caused by the operation of such equipment.
- Metal components shall be factory pre-treated, primed and baked enamel finished.
- The Contractor shall submit samples of the manufacturer's standard colours available for the Engineer's review and selection.
- All devices shall be installed inside the enclosure and no device shall be installed on the door or outer surface of any panel.
- Devices such as meters, meter switches, circuit breakers, indication lamps, relays, alarm buzzer etc. shall be arranged in an orderly, systematic manner so as to easily read.
- Doors shall be fully openable for ease of installation or removal of devices.
- The grounding terminal of enclosures shall be connected to the nearest reinforcing bar of the concrete structure on which the panels are mounted. PVC insulated wire of 25 mm² or larger shall be used for grounding.

25.7.3 Circuit Breakers

Circuit breakers shall be 600 V Class MCCB (Moulded Case Circuit Breakers) rated as shown on the Drawings.

25.8 INSPECTION AND TESTING

The Contractor shall prepare a comprehensive testing programme for inspection and testing of the electrical works. The programme for inspection, testing and commissioning of electrical works shall be part of the comprehensive manual for all mechanical and electrical works described in clause TS 24.2.14.1. Procedures for submission and approval shall be in accordance with clauses 1.4 and 1.5 of the General Specification.

The inspection and testing programme shall include all items to be inspected, schedule, parties to witness such tests and inspections, acceptance criteria and pertinent information relating to each event.

Inspection sheets for the recording of all tests and inspections shall be completed for each test and inspection and shall be submitted to the Engineer for approval on completion.

25.9 MEASUREMENT AND PAYMENT

25.9.1 Main Control Panel

This clause covers the method of payment for the main control panel as shown on the Drawings and specified in clause TS 25.5

Payment shall be made at the lump sum price entered in the priced Bill of Quantities following completion of testing of the entire mechanical and electrical systems to the approval of the Engineer.

Payment shall constitute full compensation for manufacturing, delivering, installing, commissioning, supervising, testing, training of local staff and all other associated costs.

The item to be paid under this clause is as follows:

Pay Item No.	Description	Unit of Measurement
C.4.1	Main Control Panel	L.S.

25.9.2 Local Switch

This clause covers the method of payment for the local switch for the auxiliary drainage pump system as shown on the Drawings and specified in clause TS 25.6

Payment shall be made at the lump sum price entered in the priced Bill of Quantities following completion of testing of the entire mechanical and electrical systems to the approval of the Engineer.

Payment shall constitute full compensation for manufacturing, delivering, installing, commissioning, supervising, testing and all other associated costs.

The item to be paid under this clause is as follows:

Pay Item No.	Description	Unit of Measurement
C.4.2	Local Switch	L.S.

25.9.3 Inspection and Test

This clause covers the method of payment for the inspection and testing of the electrical works specified in clause TS 25.8.

Payment shall be made at the lump sum price entered in the priced Bill of Quantities following completion of all inspection and testing to the approval of the Engineer.

Payment shall constitute full compensation for supplying the tools, specialised equipment, specialised personnel, the cost of expenses for the Engineer or his Representative to attend specified workshop test and any associated costs.

The item to be paid under this clause is as follows:

Pay Item No.	Description	Unit of Measurement
C.4.3	Inspection and Test	L.S.