

- | | | |
|-----|---|---|
| (d) | Bronze castings | JIS H5111, BC6 |
| (e) | Phosphor bronze castings | JIS H5113, PBC2 |
| (3) | Forgings | |
| (a) | Carbon steel forgings | JIS G3201, SF40 |
| (4) | Miscellaneous materials | |
| (a) | Self-lubricating bearing | JIS H 5102, high strength brass casting, HBsC4 (Min.HB 210) incorporated with the solid lubricant |
| (b) | Stranded wire ropes or 6xFl (29) construction (galvanized)
Langs Z or S lay construction | JIS G 3525, Grade G, 6x37 |
| (c) | Wire rope fittings | Manufacturer's standard fittings for the type of wire rope used |
| (d) | Steel conduit for air and water piping | JIS G 3452 |
| (e) | Steel conduit for electric wiring | JIS C 8305 |

T7.2.10 Lubrication

Before assembly, all bearing surfaces, journals, and grease and oil grooves shall be carefully cleaned and lubricated with an approved oil or grease. After assembly, each lubricating system shall be filled with an approved lubricant. Self-lubricating bearings shall be cleaned with clean rags, and greased with an approved lubricant before assembly. Solvent shall not be used on the self-lubricating bearings. The specification of all approved lubrications shall be mentioned in the Operation and Maintenance Instructions.

Provision shall be made for lubricating all bearing, including ball and roller bearings, by a pressure gun system. All lubrication nipples shall be readily accessible.

Where accessibility to a bearing for lubricating purposes is difficult, provision shall be made for remote lubrication or safe access to the lubrication point.

Ball and roller bearings shall be packed with grease during initial assembly.

All bearings and gear cases shall be made grease and oil-tight and drip pans shall be provided where necessary to prevent excess oil or grease dripping to the floor or deck.

The Contractor shall submit a list of lubricants and recommended storage quantities to be held at the site. The Contractor shall provide one hundred and ten percent (110%) of all kinds of oils and greases required for initial filling. The oil and grease shall be of a type available in Mauritius as approved by the Engineer, if applicable. The type available in Mauritius shall be investigated by the Contractor himself.

T7.2.11 Fabrication

The equipment including hydraulic system shall be designed and fabricated in accordance with the relevant standards, unless otherwise specified.

Fabrication of plate and structural steel work shall be performed in accordance with the best modern practice, true to line and free from warp or twist.

The connection between each structural member shall be made by means of bolting or welding and designed in such a manner that all forces are transmitted wholly by bolting or by welding. No sharing of specific load by two types of connection shall be accepted.

When bearing type bolts are used, they shall be so proportioned that the unthreaded part of the bolts shall resist the load at the reamed holes of the materials together with washers having a minimum thickness of 5 mm . For all sloping surfaces, bevelled washers shall be provided. For high strength tensile bolt connections, lock nuts and washers shall be provided.

All edges of plates to be welded shall have the edge prepared by machining or other approved methods so as to be suitable for the type of weld employed.

Where damage occurs in transit, the Contractor shall specify the technique of repair and obtain written approval of the Engineer before proceeding with such repair.

T7.2.12 Mechanical Parts for Equipment

The mechanical equipment and parts for the gate shall conform to the following requirements unless otherwise specifically mentioned:

(1) Ropes, Drums and Sheaves

The hoisting rope, except where otherwise noted, shall be galvanized, flexible, improved plough steel wire type with fiber core and internal lubricant.

The factor of safety of the hoisting shall not be less than eight (8). The required breaking strength of the rope shall be specified in the Contractor's order to the rope manufacturer.

The rope systems shall be equalized and arrangements entailing reverse bends shall be avoided wherever possible.

Rope drums shall be of cast iron, cast steel or fabricated steel with machined grooves. Paired rope drums shall have the same diameter to the bottom of the groove. Grooves shall be smooth machined with an adequate depth. Drums shall have sufficient width to wrap the full length of rope, and two and a half grooves when the gate/stoplog is fully closed position.

The rope end shall be secured to the outside of the drum by means of a clamp or other approved means. The fastening shall be easily accessible to facilitate rope removal or replacement.

The minimum pitch diameter of rope drums and sheaves shall be $19D$ and $17D$ for 6 x 37 construction rope respectively, where D is the diameter of the rope.

Fleet angles for grooved rope drums and sheaves shall not exceed 4 degrees.

Rope sheaves shall be Vee-grooved with an included angle of 52 degrees and groove depth equal to 1.5 times the rope diameter. The groove diameter shall be slightly in excess of the rope diameter to prevent pinching. The hook for sheave block shall be capable of rotating freely.

(2) Bearings

Bronze bushed bearings shall be used for all low speed shafts, and high speed ball or roller bearings shall be used for all other locations.

Shafts and bearings shall be proportioned so that the length does not exceed one and one half times the shaft diameter for bronze bearings not so as to exceed an allowable bearing stress at the projected area.

(3) **Keys and Keyways**

Keys and keyways shall be designed in accordance with the relevant standards. Where taper keys are used, they shall be provided with a gib head or other suitable provisions to facilitate withdrawal. Feather keys shall be secured in position by means of counter-sunk screws through the key.

T7.3 Detailed Specifications for Diversion Closing Gate

T7.3.1 General

One set of vertical lift slide type diversion tunnel gate, with guide frames, steel hoist tower and appurtenant parts complete with all necessary accessories, shall be designed, supplied and installed in the inlet structure of diversion tunnel. The diversion gate shall be used for turning off river flow from the diversion tunnel to the original riverbed and subsequent installation of river outlet facilities in the diversion tunnel, after completion of the dam with a temporary winch.

The gate shall be designed to be capable of closing and opening under any conditions given hereinafter. Guide frames of the gate shall be installed prior to the river diversion work. The Contractor shall operate the gate as directed by the Engineer.

The Contractor shall exercise special care in the design of the gate to avoid any vibration during operation of the gate and any water leakage under the fully closed condition. The general data for the design of the diversion gate in sub-clause T7.3.3 "Design Data" shall not be altered. The arrangement of the diversion gate and hoist tower shall be as shown on the Drawing No. M-001.

The hoist tower may be submerged during the dam construction work by Lot-II. The diversion gate shall be installed by Lot-II after the completion of the dam. During the dam construction work, the diversion gate shall safely be stored near the tunnel inlet, protected with a suitable cover sheet.

T7.3.2 Design Stresses

Design stresses shall conform to those specified in sub-clause T7.2.2.

T7.3.3 Design Data

(1) General data

Type of gate	:	Steel slide gate
Quantity to be provided		
Gate leaf	:	1 set
Guide frame	:	1 set
Hoist tower	:	1 set
Clear span of gate	:	6,800 mm
Clear height of gate	:	6,800 mm
Design head	:	60.000 m
Operation head	:	9.000 m
Sill elevation	:	EL.129.000 m
Water seal	:	4 edges rubber seal at downstream face of gate
Type of hoist tower	:	Fixed gantry type
Hoisting height	:	9.500 m
Operation method	:	By portable wire rope winch

(2) Gate

(a) Hydrostatic load

Head water at elevation of 189.000 meters and tail water below sill beam at elevation of 129.000 meters.

(b) Operation

The gate will be raised and lowered under imbalanced water head condition of EL. 138.00 meters.

The gate shall be capable of closing the inlet opening of diversion tunnel upon overcoming all frictional resistance force due to bearing plate, seals, side rollers and so forth when the gate being lowered by its own weight to shut off full water flow to the diversion tunnel.

(c) Other loads

Reaction due to its own weight. All loads imposed during starting, raising and lowering the gate, including any hydrodynamic force acting on the upstream face of the gate.

(d) Overload conditions

All loads imposed during operation, due to the gate jammed condition.

(3) Guide frame

The loading on the guide frame shall be the bearing and seal load, and all other loads due to the most adverse operation of the gate. The guide frame and its anchors shall be capable of transferring all the loads to the concrete structure and of preventing harmful deflection of guide frame due to placing concrete.

(4) Hoist tower

The hoist tower shall be designed to raise, lower and hold the gate in any position between fully lowered and fully raised positions. The capacity of the hoist tower shall be adequate to raise, lower and hold under the most adverse combination of the loads due to hydraulic loads specified in this subclause. The requirements for frictional coefficients shall conform to the requirements of sub-clause T7.2.7 "Coefficient of Friction" of the Technical Specifications.

T7.3.4 Gate Details

(1) General

The gate shall consist of skin plate, main beams, bearing plate, seals, side rollers, lifting attachments and all other necessary components. The gate shall be of the slide gate and of all welded construction.

The seal weld shall be made where required for the water tightness.

The details of the construction of the gate not specified herein will be left to the Contractor, upon approval of the Engineer.

(2) Skin plate

The skin plate shall be at the downstream face of the gate.

(3) Main beams

The main horizontal beams shall be of H-beam or built-up plate girder construction.

(4) Side rollers

Two (2) side rollers shall be provided on each side of the gate to limit the lateral movement of the gate. The side rollers shall be provided with the self-lubricating bushings with the lubricating system as referred in paragraph 4 of this subclause and corrosion resisting steel pins and location washers.

The roller and pin shall be designed to resist the load imposed due to the gate being jammed in the guide frame. The locations of side rollers shall be developed based on the structures of side guide frames at the inspection pits as referred to in paragraph 6 of sub-clause T7.3.5 "Guide Frame Details", so as to always ride on the side roller paths of the side guide frames for smooth operation of the intake gate.

(5) Seals

The gate seals shall be of the moulded rubber shape clamped to the downstream face of the gate using bars, bolts, nuts and washers. The side and lintel seals shall be of the caisson type or other approved shape activated to the water pressure. The bottom seal shall be of the plain rubber which bear on the sill beam.

(6) Tolerances

The gate shall be accurately fabricated and installed within the following tolerances:

Points to be measured	Tolerances (mm)
Gate width	± 7
Gate height	± 7
Gate depth	± 3
Diagonal length difference	± 8
Distance between bearing plates	± 7
Distance between side roller paths	± 7

Position of side rollers	± 6
Distance between side seal rubbers	± 10
Distance between bottom seal and top seals	± 7

The tolerances not specified herein shall be made by the Contractor, upon approval of the Engineer.

T7.3.5 Guide Frame Details

(1) General

The guide frame shall consist of sill beam, side frames and all other necessary components for the complete and satisfactory installation of the guide frames. The details of construction of the guide frame not specified herein shall be made by the Contractor, upon approval of the Engineer.

(2) Sealing frames

The sealing frames shall consist of sealing plates made of corrosion resisting steel and attached to the surfaces of sealing frame. When the guide frame has been assembled, all the sealing surfaces shall be straight, true and in the same plane within the specified tolerances.

(3) Lintel beam

The lintel beam having the sealing plate made of corrosion resisting steel thereon shall be true to form and free from twist and warp to provide a watertight seal with the gate top seal. Armoured plate against erosion shall be provided on the beam.

(4) Track frames

The track frames shall be capable of transmitting the water load from the bearing plate of the gate to the concrete structure. The surface of the track frames shall be provided with the corrosion resisting steel bearing plates and be true and flat. The surfaces shall be suitably machined and have the hardness rather higher than that of the contact surface of bearing plates of the gate to prevent excessive wear. The track frame shall be provided up to EL. 138.000 meters.

(5) Sill beam

The sill beam shall be straight and true to provide a close fit with the bottom seal of the gate. The corrosion resisting steel sealing plate shall be attached to the above surface of the sill beam. The surface of the sill beam shall be flushed with the intake canal sill and shall be fitted and attached to the side guide frames at the corners to form a continuous seal when the gate is fully closed.

(6) Side guide frames

The side guide frames consist of the side roller paths and frames. The side guide frames shall have ample strength to resist the load of the side rollers. The assembled side roller paths and the surfaces of side guide frames shall be provided up to EL. 138.000 meters.

(7) Tolerances

The guide frames shall be accurately fabricated and installed within the following tolerances:

Points to be measured	Tolerances (mm)
Clear span	± 7
Sealing span	± 7
Distance between track frames	± 7
Height of guide frames	± 8
Distance between side roller paths	+ 8, - 0
Flatness of side sealing surface	$\pm 0.5/m$
Straightness of side sealing frames	± 1
Flatness of sill beam surface	$\pm 0.5/m$
Straightness of sill beam surface	± 2
Flatness of track frame surface	$\pm 0.5/m$
Straightness of track frame surface	± 1
Straightness of side roller paths	± 5

The tolerances not specified herein shall be made by the Contractor, upon approval of the Engineer.

T7.3.6 Hoist Tower Details

The hoist tower shall be of all welded construction and consist of two (2) sets of posts, top beam, top and lower sheave blocks and all other necessary components. Arrangement of the hoist tower

shall be as shown on the Drawing No. M-001. The capacity of the tower shall be ample to operate the gate under any possible operating conditions.

The details of the hoist tower not specified herein shall be made by the Contractor, upon approval of the Engineer.

T7.3.7 Installation at Site

The gate leaf complete with the seals, guide rollers and arms shall be assembled and erected in accordance with the details shown in the final approved drawings and in accordance with the Engineer's instructions. Joints shall be watertight where required. The bottom of the gate, when erected, shall be in true alignment to ensure a tight and even bearing of the skin plate and rubber seal on the embedded sill beam. The sides of the gate shall be in true alignment so that the rubber seals, when installed, will have tight and even bearing on the sealing surfaces embedded in the concrete. It shall be the Contractor's responsibility to establish the field tolerances necessary to meet the specified tolerances.

The guide frames shall be assembled in their blockouts in accordance with the final approved drawings, brought to line and grade within the tolerances specified and firmly secured in place. Alignment bolts or other necessary devices shall be used to install the guide frames, at corresponding accurate position. Corrections between the guide frames, anchored materials and the alignment devices shall be adjustable and firmly tightened to hold the guide frames securely in position while concrete is being placed in the blockouts. Additional bracing shall be provided where necessary to ensure the required alignment.

Extreme care shall be taken to ensure that the guiding, bearing and sealing surface lie in a true plane within the tolerances specified in their entire length. Placement of concrete in the blockouts shall not proceed until the guide frames have been completely assembled and secured. During placing of concrete, alignment and tolerances shall be checked and remedial action taken if readings indicate that displacement has occurred.

T7.3.8 Test on Completion

After completion of the installation work at the Site, the tests shall be performed by the Contractor in accordance with the approved test procedure which contains the test items in the following paragraphs:

(1) Primary Tests

The primary tests shall include but shall not be confined to:

- (a) Inspection by feeler gauge measurement of satisfactory seating of all seals,
- (b) Insulation resistance tests on all wirings and electrical connections made at the Site,
- (c) Inspection for satisfactory installation of all components.

(2) Operation Tests

The operation tests shall include but shall not be confined to:

- (a) Measurement of operation speeds,
- (b) Check of water leakage,
- (c) Check of limit switches of travel, accuracy of indication and limit switch setting,
- (d) Check of emergency operation by handle of solenoid valves for opening flap gates,
- (e) Check of emergency operation by gravity operated valve for emergency opening flap gates,
- (f) Check of satisfactory operation under dry condition and an acceptable reservoir water level, including check for remote control cabinet and panel.

T7.4 Measurement and Payment

Measurement for payment for the hydromechanical works shall be made on the basis of the actual weight in tons of the diversion gate, hoist and guide frames installed in accordance with the Drawings and Specifications and as directed by the Engineer.

Payment will be made for the weight in tons measured as provided above at the respective unit price per ton stated in the Bill of Quantities, which unit price shall cover the supply, fabrication, transportation, installation, testing and any other relevant works required.

CHAPTER T8 ELECTRICAL WORKS

T8.1 Distribution Lines

T8.1.1 General

The following distribution lines shall be constructed under the Contract:

- (1) 22 kV line for shifting a part of the existing 22 kV line as shown on the attached drawing, approximately 1.0 km, single circuit, ACSR 95 mm².
- (2) 22 kV feeder line No. 1 from the 22 kV switching station to the quarry site crossing over the Bell Village Phoenix Trunk road, through water treatment plant, approximately 1.2 km, single circuit, ACSR 58 mm².
- (3) 22 kV feeder line No. 2 from the 22 kV switching station to the left bank side of dam site, approximately 0.3 km of overhead line, single circuit, ACSR 58 mm², and approximately 0.4 km of underground power cable line, 22 kV XLPE 1 core x 3 triplex type Al 60 mm².
- (4) 22 kV feeder line No. 3 from the 22 kV switching station to the entrance of borrow area, through repair shop/ware house, office and quarter area, approximately 1.2 km, single circuit, ACSR 58 mm².
- (5) 400 - 230 V line from the receiving station to the consumers in the office and quarters area, approximately 0.5 km, three circuits, OW 100 mm².
- (6) 22 kV distribution lines, all of feeder No. 1 and a part of feeder No. 3, shall be removed after the completion of the construction works by the Contractor.

Extension lines from the abovementioned lines to each working site are to be constructed by the other contractors.

The quantity of distribution line materials entered in Schedule II is provisional and will be subject to change after completion of site survey and preparation of the material schedule.

There are intermediate distribution transformers to step down the voltage to supply the power to consumers on the line route. The arrangement of the transformers and other materials required for the above shall be included in this Contract.

The approximate route of the distribution line and the location of receiving stations and the system diagram are tentatively shown on Drawing No. C-111 to C-115.

The extended distribution lines for construction use will be relocated to the suitable position by the Contractor with his own expense.

T8.1.2 Power Conductors and Ground Wires

Power conductors shall be aluminium conductor steel reinforced (A.C.S.R.) for 22 kV line and outdoor insulated wire (OW) made by copper conductor. They shall comply with the following requirements and characteristics.

	A.C.S.R.		OW 100
	Size (sq. mm)	58	95
Stranding (mm)	Al 6/3.5	6/4.5	Cu 19/2.6
	St. 1/3.5	1/4.5	
Ultimate strength not less than (kg)	1,980	3,180	—
Resistance at 20°C (ohm/km)	0.497	0.301	0.185

The power conductors shall be wound on a stout wooden drum.

T8.1.3 Joints and Connectors

Midspan joints shall be of compression type and shall be free from slipping off, damage to or failure of the conductor, or any parts thereof at a load less than 95% of the ultimate strength of the power conductor.

The electrical conductivity and current carrying capacity of joints for power conductor shall not be less than those of equivalent length of the conductor.

Connectors for conductor shall be of bolted type, with grooves and alloy bolts, complete with compound for connectors to prevent breaking out of oxide film on the conductor's surface.

T8.1.4 Insulators

Insulators shall be made of brown coloured porcelain, the line post and suspension insulators for 22 kV line, and spool insulators for 400 - 230 V line shall be supplied. Suspension insulators shall be of ball-socket type and the dimension of socket and pins shall comply with the IEC Recommendation, Publication 120, 16 mm pin and socket. Insulators for 400 - 230 V line shall be of a spool type for straight, heavy angle and dead end points.

Their characteristics shall be as follows:

For 22 kV line

		<u>Line Post Insulator</u>	<u>Tension Insulator Set</u>	
			(Disc)	(String)
Flashover Voltage (Average)				
Power frequency, dry (kV)		105	80	160
Power frequency, wet (kV)		75	50	90
Impulse	(kV)	165 (positive)	125	270
Cantilever strength	(kg)	700	—	—
Tensile strength	(kg)	—	12,000	12,000

For 22 kV line

		<u>Spool Type Insulator</u>
Flashover Voltage (Average)		
Power frequency, dry (kV)		15
Power frequency, wet (kV)		8
Leakage distance	(mm)	50 (positive)
Transverse strength	(kg)	910

T8.1.5 Fittings for 22 kV Insulators

The line post insulator shall have a suitable clamp to support the power conductor on the top of the insulator.

Insulator set for tension support shall be provided with two suspension insulator discs and all fittings including a tension clamp shaped as shown on Drawing No. C-113 for reference.

All bolts, nuts and cotter pins shall be not less than 16 mm in diameter.

The tension clamp shall be of wedge type and made of bronze casting or malleable iron and be free from slipping off, damage to or failure of the complete conductors at a load encountered in actual use.

T8.1.6 Fittings for 400 - 230 V Insulator

The 400 - 230 V outdoor insulated wire of 100 mm² shall be fixed to spool insulator by preformed grips for straight line and by insulated tension clamp for tension and dead end lines.

T8.1.7 Supports

Supports shall be steel tubular poles for both 22 kV and 400 - 230 V lines, complete with galvanized steel angle arms, anchor logs and guy wire sets where necessary.

22 kV line poles shall be of round section and the diameter of top section shall be not less than 16.5 cm for straight line and not less than 21.6 cm for tension and dead end lines.

400 - 230 V line poles shall be of round section and the diameter of top section shall be not less than 8.9 cm for straight, angle and dead end lines.

Line conductors shall be arranged in horizontal on one cross arm for 22 kV line and shall be arranged in vertical for 400 - 230 V line.

The standard types of supports for 20 kV lines are as follows

- Type-A : Straight line and light angle support up to 5 degrees with line post insulators.
- Type-B : Heavy angle support up to 30 degrees with double line post insulators and double cross arms.
- Type-C : Terminal and heavy angle support up to 60 degrees with line post and suspension insulators and double cross arms.
- Type-D : Heavy angle support up to 90 degrees with line post and suspension insulators and double cross arms.

All supports of Type A shall be designed without guy wires. Other types shall be reinforced with necessary guy wires.

Type A support shall not be used for 5 continuous section.

The standard span in the design shall be as follows.

- 60 meters for the 22 kV distribution line with ACSR 95 and 58 mm²
- 30 meters for the distribution line with OW 100 mm²

The lowest arm height from the ground level, spacing and other dimensions shall be as given on Drawing No. C-113.

T8.1.8 Design Conditions of Poles

All supports and arms shall withstand the following loads:

- (i) Vertical loads
 - a) Weight of supports, conductors, groundwires, communication cable, insulators, etc. The weight span shall be taken as 150% of the standard span.
 - b) Vertical load caused by installation of the guy wires.
 - c) Weight of worker and pole transformer, 200 kg.
- (ii) Transverse loads.....
 - a) Wind pressure at right angle to the line and support on the whole projected area.
 - b) Transverse component of angle effect due to the maximum working tension of conductors and ground wires.
- (iii) Longitudinal loads..... 100% of the maximum working tension of conductors, groundwire and communication cable for Type C and D.

Wind loads shall be assumed as follows:

- (i) On conductor, ground wire and 25 kg/m² on projected area
communication cable
- (ii) On wooden pole..... 25 kg/m² on projected area
- (iii) On arm, insulator set, etc. 50 kg/m² on projected area

(No wind pressure may be considered for guy wires and jumper conductors.)

The ambient temperature shall be assumed to vary within the range, 40°C maximum and 10°C minimum.

The maximum working tension shall be as follows:

	<u>95 mm²</u>	<u>58 mm²</u>
Line conductors	190 kg	220 kg

The maximum working tension of the ground wire shall be so selected that the sag of the ground wire at minimum temperature in still air is 80 percent of the sag of the conductors at the same condition.

In design of support for 22 kV and 400 - 230 V lines, consideration shall be given on installation of the following communication cable to be hung on the supports.

1 x CCP - AP - SS 20 P, 0.9 mm

The design calculation and drawings of supports shall be submitted by the Contractor for approval.

T8.1.9 Guy Wire Assembly

A guy wire assembly shall consist of a steel band with a thimble and preformed grips, a guy insulator with performed grips, steel guy wire and a screw type anchor with a thimble and a preformed grip as shown on Drawing No. C-113. All items shall be galvanized and the guy wire may be so designed as to withstand the load of the angle effect and conductor tension with a factor of safety of more than 2.5. The design calculation and drawings of guy wires shall be submitted by the Contractor for approval.

T.8.1.10 Grounding Materials

Grounding rods shall be made of copper clad steel rods and provided with copper lead wires. The lead wire shall be 8 mm² in size of 1.5 m in length. The size of rod shall be 14 mm in diameter and 1.5 m in length.

Grounding wire to connect the overhead grounding wires and other metal part to the grounding rods shall also be 8 mm² copper wire.

T8.1.11 Arm, Bands and Others

Galvanized steel arms with arm ties shall be as shown on Drawing No. C-113.

Long bolts for fixing arms, arm ties and pole anchors shall also be supplied. All bolts shall be made of galvanized steel as shown on the abovementioned drawings.

T8.2 Receiving Switching Station

T8.2.1 General

22 kV receiving switching station equipment from the Central Electricity Board (CEB) to the Project which is to be supplied under this sub-section shall include the following:

- (1) 22 kV switchgear
- (2) Lowtension switchgear

The apparatus supplied under this sub-section shall withstand the following test voltage:

- (1) 22 kv Switchboard apparatus

Impulse, full wave	150 kV
Power frequency	50 kV
- (2) 400 V switchboard apparatus

Power frequency	22 kV
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The receiving station shall be of outdoor metal clad type and constructed near the water treatment plant of which the switching station will be used permanently for office, quarters and dam site facilities.

T8.2.2 22 kV Switchgear

22 kV Cubicles

The cubicle shall be of outdoor use, metal-clad, sheet steel cubicle of robust construction provided with access doors which can be key locked to prevent accidental contact with live parts.

Control switch for circuit breaker, all necessary indication and fault annunciation shall be given on the swing panel board in the cubicle. The access doors shall have a sheet of clear glass for supervision.

The outdoor cubicles shall consist of the following:

- (1) 1 - Incoming (receiving) line cubicle
- (2) 3 - Outgoing feeder circuit cubicles
- (3) 1 - Station service cubicle

Incoming Line Cubicle

The cubicle shall be mounted with the following:

- (1) 1 set - Metering outfit with watthour and demand meters
- (2) 1 set - Circuit breaker, drawout type, 24 kV, 600 A, 12.5 kA
- (3) 3 - Current transformers, 100/5 A
- (4) 3 - Overcurrent relays
- (5) 1 - AC ammeter, 0 - 100 A
- (6) 1 - Ammeter changeover switch
- (7) 1 - Power factor meter
- (8) 1 - Wattmeter
- (9) 1 set - Indicating lamps for circuit breaker, "ON" - "OFF"
- (10) 1 set - Cable end
- (11) 1 set - Main busbar (insulated)
- (12) 2 sets - Fluorescent lighting fixtures, 20 W x 1
- (13) 1 set - Convenience outlet, 2 P, 250 V, 10 A
- (14) 1 set - space heater with thermo-regulating switch
- (15) 1 set - Terminals and other necessary apparatus

Outgoing Feeder Circuit Cubicles

Each cubicle shall be mounted with the following:

- (1) 1 - Circuit breaker, drawout type, 24 kV, 600 A, 12.5 kA
- (2) 1 set - Main busbar
- (3) 3 - Current transformer, 50/5 A
- (4) 3 - Overcurrent relays
- (5) 1 - AC ammeter, 0 - 50 A

- (6) 1 - Ammeter changeover switch
- (7) 1 - Power factor meter
- (8) 1 - Watthour meter
- (9) 1 set - Indicating lamps for circuit breaker, "ON" - "OFF"
- (10) 1 set - Cable end
- (11) 1 set - Main busbar (insulated) with fittings
- (12) 2 sets - Fluorescent lighting fixtures, 20 W x 1
- (13) 1 set - Convenience outlet, 2 P, 250 V, 10 A
- (14) 1 set - Space heater with thermo-regulating switch
- (15) 1 set - Terminals and other necessary accessories

Station Service Cubicle

This cubicle shall be provided for the station service of the receiving switching station. All necessary indication and no-fuse breakers shall be provided on the swing panel in the cubicle. The cubicle shall be mounted with the following:

- (1) 1 - Fused disconnecting switch, 24 kV, 600 A, fuse 10 A
- (2) 1 set - Main busbar (insulated)
- (3) 1 set - Transformer, 3 phase, 20 kVA, 22 kv/400 - 230 v
- (4) 1 - Grounding potential transformer, 3 phase, 22 kV/110 V/ $\frac{110}{3}$ V
- (5) 1 - Undervoltage relay
- (6) 1 - AC voltmeter, 0 - 25 kV
- (7) 1 - Voltmeter changeover switch
- (8) 1 - Ground overvoltage relay
- (9) 1 - Three phase potential transformer, 400/110 V
- (10) 1 - AC voltmeter, 0 - 500 V
- (11) 1 - voltmeter changeover switch
- (12) 1 - Single phase current transformer, 50/5 A
- (13) 1 - No-fuse breaker, 4-pole, 550 v, 50 AF
- (14) 2 - No-fuse breakers, 3-pole, 550 V 30 AF
- (15) 2 - No-fuse breakers, 2-pole, 250 V, 30 AF
- (16) 2 sets - Fluorescent lighting fixtures, 20 W x 1
- (17) 2 sets - Convenience outlets, 2 P, 250 V, 10 A
- (18) 1 set - Space heater
- (19) 1 set - Cable ends
- (20) 1 set - Terminals and other necessary apparatus

Particulars of Cubicle Apparatus

Particulars of main component equipment of the cubicle specified in this Clause shall be as given hereunder:

(1) 22 kV circuit breaker - The circuit breaker shall be of indoor use and the ratings shall be as follows:

- (a) Type : Vacuum or minimum oil
- (b) Rated voltage : 24 kV
- (c) Rated current : 600 A
- (d) Rated interrupting current : 12.5 kA
- (e) Operating duty : 0-1 min. - CO-3 min. -CO

The circuit breaker shall usually be operated electro-magnetically by operation of a control switch on the cubicle.

The following shall be fitted as accessories:

- (a) Name plate
- (b) Position indicating lamps
- (c) Auxiliary switches
- (d) Operation counter
- (e) Other necessary accessories

(2) 22 kV fused disconnecting switch - The fused disconnecting switch shall be of indoor, three pole, single throw and mechanically hand operated type with fuse element and necessary accessories and ratings shall be as follows:

- (a) Rated voltage : 24 kV
- (b) Rated current : 600 A
- (c) Rated fuse element : 5 A

The load break switches with power fuse will be acceptable on the condition that the switch can interrupt the exciting current of the 20 kVA transformer.

The operation rod for the disconnecting switch shall be supplied as accessories.

Particulars of Outdoor Apparatus

Particulars of outdoor apparatus specified in this Clause shall be as given hereunder: -

- (1) 22 kV disconnecting switch - The disconnecting switch shall be of outdoor, three-pole, single throw and mechanically hand operated type with necessary accessories and ratings shall be as follows: -

- (a) Rated voltage : 24 kV
(b) Rated current : 400 A

The operation rod for the disconnecting switch shall be supplied as accessories.

- (2) 22 kV lightning arrestors - The lightning arrestors shall be of outdoor use, gapless type with suitable fittings for mounting on the distribution line pole and the ratings shall be as follows :

- (a) Rated voltage : 28 kV
(b) Rated discharge current : 5 kA

Each arrester shall have clamp type terminals for ACSR of 58 mm² for the line sides and for copper wire of 38 mm² for the grouting side.

T8.3 Receiving Station

T8.3.1 General

Receiving station equipment for each site supplied under this sub-section shall include the following:

- (1) Receiving transformers
(2) 22 kV switchgear
(3) Lowtension switchgear

The apparatus supplied under this sub-section shall withstand the following test voltage:

- (1) 22 kV switchboard apparatus
Impulse, full wave 150 kV
Power frequency 50 kV

- (2) 400 - 230 V switchboard apparatus
Power frequency 22 kV

T8.3.2 Receiving Transformers

General

Unless otherwise specified hereunder, requirements in sub-section 2 shall also apply to this Clause.

The following transformers shall be supplied for each receiving station:

- (1) Two (2) sets of three-phase, oil immersed, natural cooled, outdoor type transformer of 30 kVA capacity for stepping down the distribution line voltage of 22 kV to 400 - 230 V, connected in delta-star. The neutral point of the 400 V star windings shall be brought out for use of 3-phase, 4-wire power system. The transformers shall be used for quarry site and borrow area respectively.
- (2) One (1) set of three phase, oil immersed, natural cooled, outdoor type transformer of 300 kVA capacity with voltage ratio of 22 kV to 400 - 230 V, connected in delta-star. The neutral point of the 400 kV star windings shall be brought out for use of 3-phase, 4-wire power system. The transformer shall be used for office and quarters.
- (3) One (1) set of three-phase, oil immersed, natural cooled, indoor type transformer 500 kVA capacity with voltage ratio of 22 kV to 400 - 230 V, connected in delta-star. The neutral point of the 400 V star windings shall be brought out for use of 3-phase, 4-wire power system. The transformer shall be used for aggregate plant, concrete plant, water treatment plant, etc.
- (4) Two (2) sets of three phase, oil immersed, natural cooled, outdoor type transformer of 400 kVA capacity with voltage ratio of 22 kV to 400 - 230 V, connected in delta-star. The neutral point of the 400 V star windings shall be brought out for use of 3-phase, 4-wire power system. The transformers shall be used for repair shop/ warehouse and dam site work respectively.

Voltage Ratio

The transformers shall have a no-voltage ratio as indicated hereunder:

F23 - F22 - R21 - F20 / 400 - 230 V

Bushings

All bushings on both 22 kV and low tension sides shall be of solid type.

T8.3.3 22 kV Switchgear

Particulars of Outdoor Apparatus

Particulars of outdoor apparatus specified in this Clause shall be as given hereunder:

- (1) 22 kV fused disconnecting switch - The fused disconnecting switch shall be of outdoor, three-pole, single throw and mechanically hand operated type with fuse element and necessary accessories and ratings shall be as follows:

- | | | |
|------------------------|---|--|
| (a) Rated voltage | : | 24 kV |
| (b) Rated current | : | 400 A |
| (c) Rated fuse element | : | 20 A for 500 kVA Tr.
15 A for 400 kVA Tr.
10 A for 300 kVA Tr.
5 A for 30 kVA Tr. |

The operation rod for the disconnecting fuse switch shall be supplied as accessories.

- (2) 22 kV lightning arresters - The lightning arresters shall be of outdoor use, valve type with suitable fittings for mounting on the distribution line pole and the ratings shall be as follows:

- | | | |
|-----------------------------|---|-------|
| (a) Rated voltage | : | 28 kV |
| (b) Rated discharge current | : | 5 kA |

Each arrester shall have clamp type terminals for ACSR of 58 mm² for the line sides and for copper wire of 38 mm² for the grounding side.

T8.3.4 Lowvoltage Switchgear

The lowvoltage switchgear shall consist of distribution switch boxes and accessories as specified hereunder.

Distribution Switch Boxes

For each transformer secondary at receiving station, a distribution switch box shall be provided complete with molded case circuit breakers and all fixing materials. The distribution switch boxes shall be made of painted steel plates with key locked front doors and mounted on tubular pole. They shall be weather-proof and incoming/outgoing cable outlets shall be provided at the bottom plate.

The following MCCB's (molded case circuit breakers) for AC 400 V circuit use shall be housed in the boxes as shown in Drawing No. C-115.

<u>Transformer Capacity</u>	<u>Transformer 2ry circuit</u>	<u>Feeder circuit</u>
500 kVA	3-P, 800 AF (800 A Trip)	4 x 400 AF (400 A Trip)
400 kVA	3-P, 600 AF (600 A Trip)	4 x 400 AF (250 A Trip)
300 kVA	3-P, 600 AF (400 A Trip)	3 x 3-P, 400 AF (250 A Trip)
30 kVA	3-P, 100 AF (60 A Trip)	2 x 3-P, 100 AF (30 A Trip)

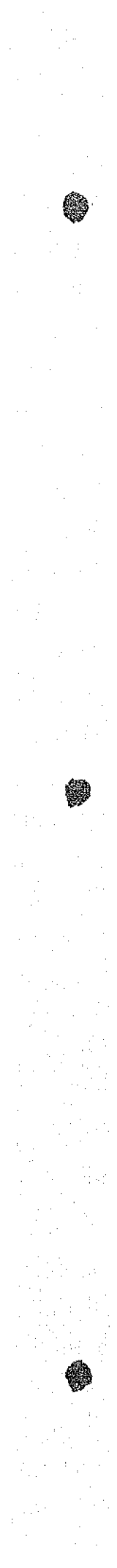
The following number of molded case circuit breakers shall be supplied as spares:

3-P, 400 AF (400 A Trip)	1 no.
3-P, 400 AF (250 A Trip)	1 no.
3-P, 225 AF (175 A Trip)	1 no.
3-P, 100 AF (100 A Trip)	1 no.

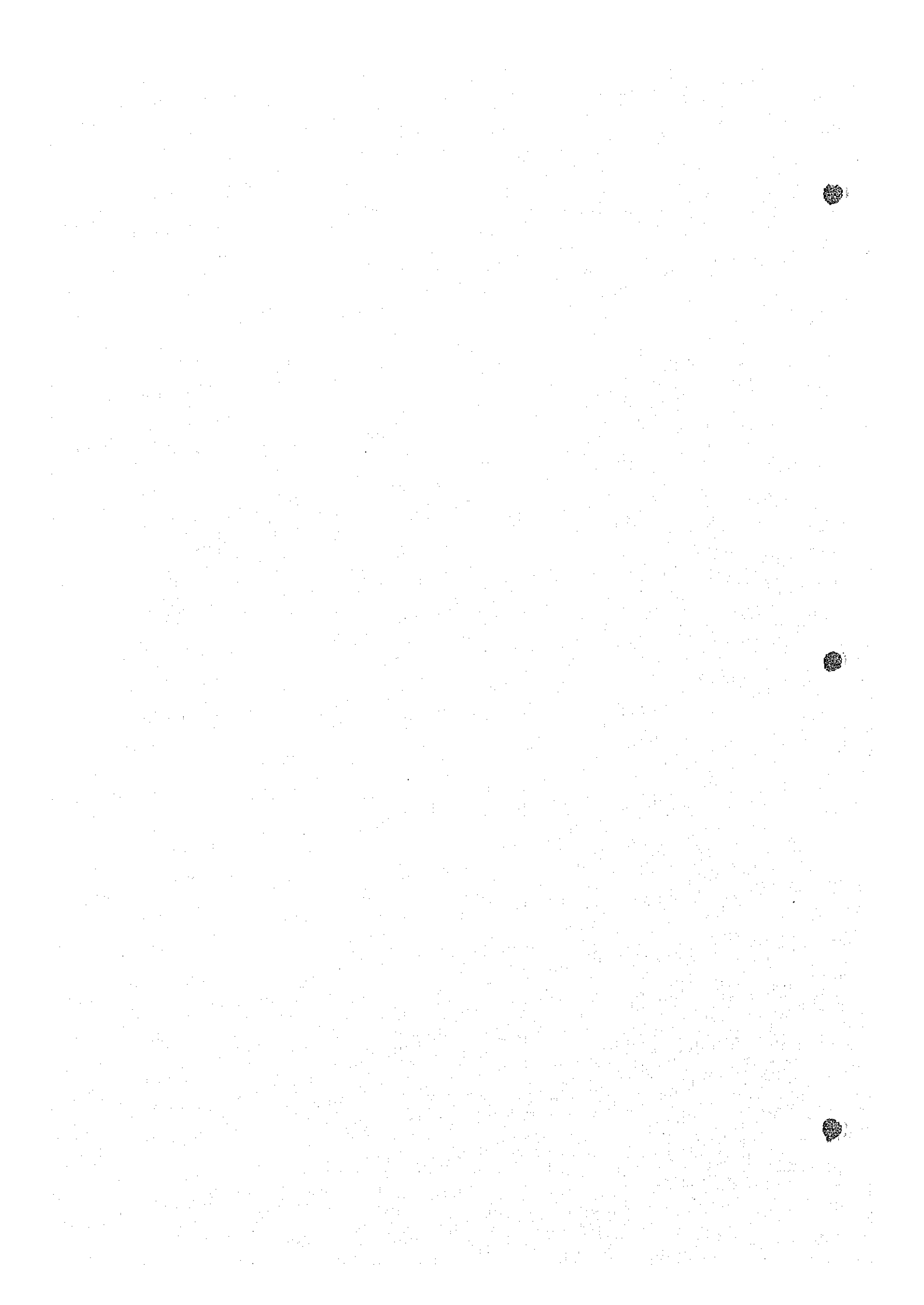
T8.4 Measurement and Payment

Measurement for payment for the electrical works shall be made on the basis of the unit of the respective items stated in the Bill of Quantities for actually installed electrical works in accordance with the Drawings and Specifications and as directed by the Engineer.

Payment will be made for quantities measured in the unit of the respective items stated in the Bill of Quantities at the respective unit price stated in the Bill of Quantities. The unit price shall include the costs of the supply, transportation, fabrication, installation at site and any other relevant works required.







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