L.4.8 Dogging Device

Two (2) sets of dogging device shall be provided at EL. 69.0 m of the uppermost portion of the Nos. 1 and 4 side guide frames at the locations shown on the Drawings for Tender No. 3-I-029. The dogging device shall be designed to support and hold the gates during rest.

L.4.9 Gratings

Six (6) sets of grating with corner metals and anchors shall be provided to cover gate slot openings at deck EL. 70.0 m, as shown on the Drawings for Tender. The gratings shall have enough strength for loading trashes on the 4.0 tons class long body truck or for passage of the fully loaded such truck under the crane, whichever is the bigger. They shall be hot dip galvanized in not less than 550 g/m^2 according to the relevant standard.

L.5 DETAILED REQUIREMENTS FOR GANTRY CRANE

L.5.1 General

The gantry crane shall consist of gantry frame, hoisting and traveling equipment, cage, rail safety clamps, controls, limit switches, cabtyre cable and reel and all other necessary components for its proper and efficient operation. The gantry crane shall be of all welded construction, except that the high-strength friction grip bolts and reamer bolts shall be used for all field connections. The details of construction of the gantry crane not specified herein, will be left to the Contractor, but subject to approval of the Engineer.

The rails (30 kilograms per meter) and their fittings and accessories shall also be provided by the Contractor as shown on the Drawings for Tender.

L.5.2 Gantry Frame and Traveling Equipment

(1) General

The traveling equipment which is electrically operated and cage controlled type as built on the gantry frame shall ride and travel on the traveling rails provided on the concrete slab at EL. 70.0 m to handle the intake gates or the rake.

The traveling equipment to be furnished shall consist of mechanical equipment, i.e., torque shafts, bearings, gear reducers, couplings, wheels, etc., electrical equipment, i. e., electric motors, limit switches, electro-magnetic breaks, etc., cage and all other necessary components.

(2) Gantry Frame

The gantry frame shall, in any case, be capable of withstanding the rated load and lateral forces due to sudden starting or stopping of the crane when the gate is transferred. The frame shall be of all welded and built-up plate girder construction using rolled structural steel shapes and plates. The lowest column shall be designed such that the reaction from all frames is divided equally between each wheel. Rail sweeper shall be provided for wheels. The frame shall be equipped with the rails clamps on the lowest column so as to hold the crane on the embedded rails at the position where operation is taken place or to prevent undue movement of the crane when it is not in operation. The top of the gantry crane shall be open, and all working parts of the mechanical and electrical components shall be designed to be protected from the weather. Easy access shall be provided to facilitate inspection and repairs. Walkways, handrails and hooped access ladders shall be provided.

(3) Mechanical Equipment

(a) Torque Shafts

The torque shafts shall be finished commercial steel shafting.

(b) Bearings

The bearings shall be of self-aligning regreasable ball or roller type.

(c) Gear Reducers

All gears except worm wheels shall be of cast or forged steel with machine cut teeth and worm wheels shall be of phosphor bronze casting. If worm gears are used, they and their supports shall be sufficiently rigid to prevent undue movements. Gears shall have removable housing with easily accessible provision for lubrication. High-speed gears shall be encased and oil bathed. Adequate inspection openings shall be provided together with an oil filler plug, drain cock and oil level indicator.

(d) Couplings

Couplings shall be provided with means for field adjustment and permanently attached to torque shafts after field adjustment.

(e) Wheels

The wheels of the crane shall be double flanged to suit the rails used. The wheels shall be of cast steel or forged steel and shall be heat-treated to provide a hard wearing surface. The wheels shall be provided with "Oiles" metal bushings turning on the fixed axles of forged steel or other approved materials. The wheels shall be machined true and shall operate smoothly without deflection or vibration.

(4) Electrical Equipment

The electric motor, motor brake, electric cables, limit switches, ammeter, indicating lights and meters shall conform to the requirements of the relevant items specified in Clause GS.7 of Part-I General Specifications.

(5) Cage

The cage shall be fixed at one end of the gantry crane and of ample size and weatherproof construction, using structural steel members and steel sheeting rigidly braced to avoid vibration and large windows in size provided at all around the cage to assist operation. A control cabinet for the gantry crane shall be provided within the cage. The control cabinet shall be equipped with all controlling and indicating instruments. A keyed door shall be provided on the cage and an operator's seat shall be provided within the cage.

The cage shall be equipped with inside lights. Floodlights shall be mounted on the gantry to provide adequate lighting for the working area. The cage shall be equipped with a suitable foot gong or siren and a floor wearing surface with the approved materials.

L.5.3 Hoisting Equipment

(1) General

The hoisting equipment shall be of the cable lift type suitably mounted on the gantry crane for raising and lowering the gate or trash rack rake with lifting beam. The hoisting equipment to be furnished shall consist of mechanical equipment, i.e., torque shafts, bearings, gear reducers, coupling, hoist drums, mechanical position indicator, manual operating device, wire ropes, etc., electrical equipment, i.e., electric motor, limit switches, electro-magnetic brake, etc. and all other necessary components.

(2) Mechanical Equipment

The torque shafts, bearings, gear reducers, couplings shall conform to the requirements of the relevant items specified in Clause L.5.2 (3).

(a) Hoist Drums

The hoist drums shall be of cast and/or welded steel construction, grooved to receive the full length of rope corresponding to the required lift plus two dead wraps on each drum at fully raised position, in addition to the length required for attachment to the drum.

When the trash rack rake is at the fully lowered position, at least three dead wraps of the rope shall remain unwound. The minimum pitch circle diameter of drums shall be 19 times the diameter of the stranded wire rope. The rope grooves shall be in accordance with the recommendations of the rope manufacturer. All surfaces which are to come into contact with the ropes shall be machined true to the approved tolerances and surface finished to minimize rope wear and to prevent permanent deformation of the rope.

(b) Mechanical Position Indicator

A mechanical gate position indicator shall be mounted on the hoist base to detect both positions of the gate and trash rack rake. The indicator shall be an easily readable dial type having pointer to rotate approximately 300 degrees for full travel. The dial plate shall be of stainless steel or brass with engraved marking. The dial and pointer shall be mounted in a dust-tight and weatherproof enclosure, and be able to read preferably by 1.0 cm.

(c) Manual Operating Device

The hoist shall be provided with a manual operating device which can hoist under the full load designed. The full force on the handle of the device shall be less than 10 kilograms per man. While the device is being operated, the electric motor shall be disengaged. The electro-magnetic brake shall have a means of manually de-energizing the brake during manual hoisting and of quickly energizing the brake when hoisting work has ceased.

(d) Wire Ropes

The wire rope assemblies shall be match-marked to exact length while under tension. The wire ropes shall be of galvanized steel, grease impregnated during manufacture, and shall be supplied by a reputable manufacturer of hoisting ropes. Wire ropes shall be selected with lay suitable for preventing kinking.

The rope shall be designed so that the normal working load does not exceed one-eighths (1/8) of the breaking strength of the rope; except that when the maximum hoist motor torque is applied, the working stress shall not exceed one-third of the breaking strength of the rope.

(3) Electrical Equipment

The electric motor, motor brake, electric cables, limit switches, ammeter, indicating lights and meters shall conform to the requirements of the relevant items specified in Clause L.5.2,(4) herein.

L.5.4 Control and Wiring

(1) Available Power

The available power for the electrical equipment to be furnished with the gantry crane shall be A.C. 220/127 volts, 3-phase, 4-wire and 60 Hz.

(2) Control System

The gantry crane shall be operated by one-man control in the cage. The hoisting equipment shall be capable of raising, lowering or stopping the gate and trash rack rake by the corresponding push-button switches. The traveling equipment shall be operated by push-button switches so as to travel in the direction as designated on each switch.

The following limit switches shall be provided on the gantry crane for proper operation.

(a) Upper overtravel limit switches to stop the hoisting equipment before either one of the lifting beam or trash rack rake strikes the hoisting equipment.

(b) Lower overtravel limit switch to stop the hoisting equipment to keep the rope would on the hoist drums.

(c) Limit switches to prevent the gantry crane overtravel.

(d) Slack rope limit switch to prevent the slackening of the hoisting ropes in the event the downward motion is stopped by an obstruction.

(e) Limit switches to prevent crab overtraverse.

The gantry crane shall be designed to have electro-mechanical interlocks so as to prevent simultaneous operation among the motors for traveling, hoisting or traversing mechanism.

(3) Wiring and Cable Reel

The Contractor shall furnish all power cables from the AC panel located in the low tension switchgear room at EL. 60.0 m of the pumping station to the main incoming supply no-fuse breaker in the control cabinet located inside the cage of the gantry crane, through the cable end post and cabtyre cable retrieving on a motor or spring-operated cable reel which shall be mounted in such a manner as to allow the gantry crane to travel over the full length of travel. The reel shall have a device to permit delivery of cable in both directions. The Contractor shall furnish all secondary power and control cables and/or wires from the control cabinet, which are necessary for the required operation of the gantry crane.

(4) Control Cabinet

The Contractor shall provide a control cabinet for operating of the gantry crane. This control cabinet shall be located in the cage. the control cabinet shall be of weatherproof construction, completely enclosed, with keyed access doors and/or windows, assembled using angle or channel structural members, seam welded at the corners and finished smooth. All necessary switches, indicators, relays, transformers and other devices shall be installed within the cabinet.

The following instruments shall be mounted on or within the control cabinet. All indicators such as meters and lights shall be visible from outside without opening the keyed doors or windows.

(a) Incoming supply no-fuse breaker lockable in "off" position,
(b) Source volt meter,
(c) Source pilot light,
(d) Load ampere meters,
(e) Starters for each motor,
(f) 127 volts convenience outlet,
(g) Fully raised indicating light,
(h) Fully lowered indicating light,
(i) Raising indicating light,
(j) Lowering indicating light,
(k) Crane traveling in right direction light,
(l) Crane traveling in left direction light,
(m) Crane stopped indicating light,
(n) Necessary alarm lights and buzzers,
(o) "Raise", "lower" and "stop" push-button switches, for the hoisting equipment,
(p) "", "Æ" and "stop" push-button switches, for the traveling equipment,
(q) Gate position indicator,
(r) No-fuse circuit breakers to protect each motor circuit and other circuits, and
(s) All other necessary step-down transformers, relays, contactors, switches, and miscellaneous wiring components.

The gate and trash rack rake position transmitters for item (q) shall be housed in the mechanical position indicator specified in Clause L.5.3.

L.6 DETAILED REQUIREMENTS FOR LIFTING BEAM

The lifting beam made of all welded construction shall be provided with two flanged side rollers on each side of it so as to ride on the tracking bars of the guide frames.

The lifting beam shall be provided with the attachment for connection of the hoisting wire. The hoisting wire connection shall be designed to be readily accessible and to be disconnected.

The lifting beam shall provide with two lifting lugs pointly connected through a linkage mechanism to engage the gate lifting attachments.

L.7 Spare Parts

Spare parts specified in Schedule - IIA and those to be recommended in Schedule - IIB in Volume-II shall be furnished by the Contractor duly.

L.8 SHOP ASSEMBLY AND TEST

L.8.1 Gates and Guide Frames

The gates including seals, guide rollers and fixed wheels shall be assembled in the shop in the approximately position that will have after installation in the intake. While assembled, the gates shall be checked for dimensions, tolerances and accuracy of alignment. Any error and misalignment discovered shall be promptly corrected. The seals shall be fitted to their supports during the shop assembly. Parts shall be clearly matchmarked before disassembly for transportation. The sealing frames, track frames, side guide frames, front guide frames, lintel beam and sill beam of the guide frames shall be checked by means of straight edge and feeler gauges. All dimensions of guide frames that correspond to the gate dimensions shall be checked and any error and misalignment shall be corrected.

L.8.2 Gantry Crane

The gantry crane shall be completely shop assembled and tested for smooth and proper performance. All units shall be tested at operating speed and at rated load described in Clause L.2 and closely checked to ensure that all necessary clearances and tolerances have been provided and that no binding occurs in any moving part. All bearings shall be carefully checked. All lubrication grease and oil required for the performance of the test shall be furnished. If any defect or improper operation is discovered, they shall be corrected and the entire test shall be repeated.

L.9 INSTALLATION

L.9.1 Guide Frames

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. Connections between 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 surfaces lie in a true plane within the tolerance specified for their entire length. Placement of concrete in blockout shall not proceed until the guide frames have been completely assembled and secured. During placing the concrete, alignment tolerance shall be checked and remedial action taken if readings indicate that displacement has occurred.

L.9.2 Gates

The gate leaf complete with seals and fixed wheels shall be assembled and erected in accordance with the details shown on the finally 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 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 a tight and even bearing on the sealing surfaces embedded in the concrete. The gate shall be assembled and erected within the shop tolerance necessary to meet the specified tolerance. Detailed descriptions and sketches of proposed methods of erection shall be submitted for approval. However, such approval does not relieve the Contractor from the responsibility of achieving the above tolerance.

L.9.3 Gantry Crane

Before assembly, all bearing surfaces, journals, and grease and oil groves shall be carefully cleaned and lubricated with an approved oil or grease. After assembly, each lubricating system shall be filled with an approved lubricant furnished by the Contractor. No solvents shall be used for cleaning "Oiles" bearings.

The gantry crane complete with all accessories, shall be assembled and installed in accordance with the finally approved drawings.

After completion of installation works, the gantry crane shall be operated and checked for proper operation, namely raising, lowering, stopping and handling of the gate with the lifting beam, trash rack rake and traveling of the crane. Any defect or improper operation discovered during the tests shall be corrected and the entire tests repeated.

SUBSECTION - M

DISCHARGE PENSTOCKS

M.1 GENERAL

M.1.1 Scope

This Subsection covers the design, manufacture testing before shipment, transportation to the Site, installation / erection, commissioning and performance tests at the site of the following:

(1) Two (2) lines of steel discharge penstocks for Severino pumping station

M.1.2 Discharge Penstocks

Two (2) lines of discharge penstock, each 1,000 to 2,000 millimeters in diameter by approximate 193 meters / 190 meters long shall be provided for six pumps in the pumping station and complete with one-way surge tanks, bend pipes, enlarging pipes, confluence pipes, dewatering pipes and valves, expansion joints, anchors, ring girders, manholes, stiffener rings, thrust collars and all other necessary components. The discharge penstocks shall extend from the guard valve outlet in pumping station to the head tank. The discharge penstocks up to Anchor Block Nos.1-2/2-2 shall be encased in concrete. All concrete works will be done by the other contractor. The Contractor shall connect the discharge penstocks to the guard valves by flange connection at inside pumping station. Water filling test along with the performance tests for the pumping equipment shall be executed by the Contractor. The layout and arrangement of the discharge penstocks shall be as shown on the Drawings for Tender, Nos.3-I-004, 005, 013, 031, 032, and 3-I-033.

M.2 DESIGN LOADS AND STRESSES

M.2.1 Design Loads and Conditions

The penstocks shall be designed for the following conditions.

(1) To resist the net internal pressure given on the Drawing for Tender, No.3-I-034. The net internal pressure shall be the sum of static head and the pressure rise due to water hammer, which are defined as follows.

(a) Static head is the difference between the centerline elevation of the penstocks / pumps and high water level at the head tank.

High water level at the head tank : EL. 114.020 m
Pump spiral casing centerline : EL. 46.000 m

(b) Pressure rise due to water hammer will be 55.26 meters at the pump center and this pressure rise is assumed to become zero at the head tank, reducing gradually along the centerline of the discharge penstocks as shown on the Drawings for Tender, No.3-I-034.

(2) The penstocks located beneath the ground level EL 70.0 m where encase in concrete shall be capable of resisting the external pressure when inside of them empty. The design external pressure shall be the head of water, equivalent to the difference between the center line of the penstocks and ground level EL. 70.0 m. A lift of concrete encasing will the expected in 2.0 m a time throughout whole length. The stiffener rings shall be fitted on the pipe shell, where required, upon calculating on condition that the circular gap between the penstock and the secondary concrete "k" vs. radius "r' be assumed as k/r = 0.0003 and the factor of safety against buckling be 1.5.

(3) The penstocks shall be capable of resisting the following conceivable axial stresses.

(a) Bending stress due to restrain the expansion of pipe shells by the stiffener rings, thrust collars and/or ring girders.

(b) Stress due to inclination of the penstock.

(c) Bending stress resulting from continuous beam of the penstocks supported by ring girder supports.

(d) Stress due to axial component by internal pressure at the expansion joints.

(e) Thrust force of guard valve at its fully closed position under design internal pressure

(f) Stress due to variation of temperature of the penstocks (20 °C during water filling), and

(g) Stress due to Poisson's effects

(4) The exposed portions of the penstocks shall resist the shearing stress resulting from continuous beam of the penstocks, and also to resist the pressure difference of 2.0 m in water head at the time of dewatering with the factor of safety at 1.5.

(5) The penstocks and their ring girder supports at the exposed portion shall withstand the flowing external pressures.

(a) Wind pressure: 0.15 tf / sq.m in the horizontally projected area

(b) Earthquake coefficient = 0.15 g in horizontal direction

(6) The embedded portion of the penstocks shall be capable of resisting the external pressure due to grouting. This grouting pressure shall be of 3.0 kgf/cm^2 and the factor of safety for buckling of the penstock against the external pressure shall be over 1.5. No corrosion allowance may be considered in this calculation.

(7) To resist the circular bending stress due to water filling at or around the ring girder supports.

(8) The main pressure - receiving parts shall be made of the hot rolled, fine grained and fully killed steel, having anti-brittle fracture, excellent notch toughness and excellent weldability as specified in ASTM A516 Grade 60/70 or JIS G3106 SM 400B/490B.

(9) To resist the loads due to handling during fabrication, transportation and field erection. The shell thickness shall not be less than the value determined from the following formula.

$$t = \frac{D + 800}{400}$$

where, t : Shell thickness in mm

D : Steel pipe inner diameter in mm

(10) The penstocks shall be designed to minimize the head losses in the penstocks during pump operation. The deflection angle between segments of a bend pipe shall not exceed 7 degrees, and the radius of curvature of a bend pipe shall not be less than 2 times the inside diameter.

M.2.2 Design Stresses

(1) Steel Materials

The allowable stresses for normal loading of steel materials and concrete stresses shall conform to the requirements of Clause GS.6.1 in Part-I General Specifications and Clause L.2.2, provided that:

(a) The circular stress, axial stress and the perpendicular stress against the axis of the pipeline, and the composite stress for normal condition shall be less than the allowable stresses as above mentioned. However, in case of addition of the bending stress on the pipe shell due to restraining the pipe shell expansion by the stiffener rings, the allowable stresses may be increased by 1.35 times the above allowable stresses.

The combined stress shall be calculated by the following formula as developed by Mises Hencky Huber.

$$fg^2 = fx^2 + fy^2 - fx \cdot fy + 3\,fq^2$$

Where, fg : Combined stress (kgf / cm^2)

fx : Circular stress
(tension is considered as positive, kgf / cm^2)

fy : Axial stress
(tension is considered as positive, kgf / cm^2)

fq : Shearing stress (kgf / cm^2)

(b) In considering an earthquake or wind pressure, the allowable stresses may be increased by 1.5 times the allowable stresses for normal condition.

(c) The allowable stresses for circular bending stress imposed to the discharge penstocks during water filling operation may be increased by 1.5 times those specified above.

(d) Where discharge penstocks are faced with corrosion - resisting steel on the water side, the corrosion - resisting steel shall be ignored when assessing the stresses, the backing materials only being assumed to take the stresses

M.2.3 Welding Efficiency

The strength of the longitudinal and girth welds on the discharge penstocks shall be rated at 90 per cent of the parent steel plate strength.

M.2.4 Welding Joints

Full penetration butt-weld joint shall be applied for all longitudinal and girth welds in the discharge penstock shells.

M.2.5 Corrosion Allowance

A thickness of 2.0 millimeters as a corrosion allowance shall be added to the calculated shell thickness.

M.2.6 Appurtenances

(1) One - way Surge Tanks

Each one - way surge tank, one for each discharge penstock lane, shall be provided at the locations shown on the Drawings for Tender, Nos.3-I-031 and 3-I-032. The one - way surge tank per set shall consist of one (1) water tank, two (2) non - return valves, two (2) guard valves, two (2) steel pipes with loose flange connections to the penstock, one (1) float valve and other necessary accessories for their satisfactory and efficient operation. High water level in the present surge tank location shall be expected at EL.101.0 m so as to supply the needed and sufficient quantity of water to the pipeline, preventing growth of negative pressure at the time of pump trip phenomenon, whereas the tank shall usually be separated from the pipeline by function of the non-return valves. This water level shall be detected always by the electrode type water level detector so as to transmit signal and indicate it on the control board of subsection - E. The diameter of non - return valves and butterfly type guard valves shall not be less than 1,100 mm. Special means shall be provided to steel pipes and loose flange connections for the penstocks, so as to absorb max. axial movement of penstocks during their empty condition without any trouble on the tank structures, and also any leakage during normal pumping operation.

The tank capacity shall be obtained in relation with the pump / motor characteristic curve and function of the non - return valve to be provided at the main pump delivery side, vide Clauses A.2.3 and A.3 herein.

The capacity and details of the tanks not specified herein will be left to the Contractor, but subject to approval of the Engineer.

(2) Expansion Joints

The expansion joints shall be provided at the location shown on the Drawings for Tender, Nos.3-I-031 and 3-I-033. The expansion joint shall be of the sleeve type and the outside surface of the inner sleeve shall be clad with corrosion-resisting steel having 3 millimeters or more in thickness. The inner sleeve and the conduit shall be smooth and uniform where they contact the sealing packings. The longitudinal movement shall be more than the value calculated from the temperature variation of 40.0 degrees C. with an allowance of 5.0 centimeters.

(3) Ring Girder Supports

The exposed portion of the penstock shall be supported by the ring girders with roller type shoes in an interval of not less than 14.0 m as shown on the Drawings for Tender, Nos.3-I-031 and 3-I-032.

(4) Stiffener Rings and Thrust collars

The stiffener rings and thrust collars where required, shall be attached on the penstock for withstanding external pressure and for transferring axial thrust forces to

the surrounding concrete structures. The structure of stiffener rings and thrust collars shall be such that concrete back filing around the pipe can be securely placed, upon releasing air around the ring structures.

(5) Manholes

The manholes in 450 mm x 350 mm elliptional and 600 mm diameter shapes shall be provided at the positions locating 45 degrees direction beneath the horizon as shown on the Drawings for Tender, No.3-I-004, 005, 031, 032 and 3-I-033. The manhole shall be made of the steel plate combined with a rubber packing, rocker arms, safety chains and other necessary components.

(6) Dewatering Pipes

The Contractor shall provide 200 mm diameter steel dewatering pipes with hand-operating valve connecting each discharge penstock and sump pit for complete draining water in the discharge penstock when maintenance work is needed. The dewatering pipes shall withstand internal pressure 13 kgf/cm^2 and shall include corrosion allowance of 2.0 millimeters.

(7) Lugs for Water Flow Meters

Due lugs shall be provided at the locations shown on the Drawings for Tender, No. 3-I-031 so as to attach ultrasonic type water flow meters specified in Clause E.7.4 herein.

(8) Joint Filler
Joint fillers shall be provided on the concrete encased-outer surfaces of the penstocks at the inlet and outlet parts thereof so as to avoid possible cracks of concrete structures at there.

(9) Saddle Plate
Saddle plates made of stainless steel shall be provided on the q = 120 degrees concrete saddles so as to hold penstock weights and also to allow axial movement smoothly.

M.3 FABRICATION

M.3.1 General

The Contractor shall cut the plates for the steel pipes to exact dimensions, prepare the edges for welding, press the edges for rolling, roll them to a curvature in the Contractor's shop and make to complete sections in the contractor's shop or field shop in accordance with the finally approved drawings.

M.3.2 Cutting and Bending

All plates shall be cut accurately to the dimensions shown on the finally approved drawings, with allowance provided for possible shrinkage during welding. All edges shall be inspected for sound metal and be free from laminations, surface cracks and other injurious defects. Cylindrical shells may be rolled or bent to true curved sections, continuous to the edges, by any process that does not impair the strength of the plates and with continuous curvature between the edges. Correction of curvature by hammering shall be avoided. For butt welding of plates of unequal thickness, the work of trimming the thicker plate shall be done in the work shop, if the difference between plate thickness is more than 3 millimeters. The orientation of the plate for the fabrication shall be such that the final direction of rolling is placed circumferentially. No stamping or groove making on the steel pipe shells shall be allowed, if it puts to part other than cutting line for fabrication purposes or leaves on the finished steel penstock surfaces.

M.3.3 Welding

In addition to the welding requirements in Clause GS.6.3 of Part-I General Specifications, the following shall govern:

(1) The surfaces of plates to be welded shall be cleaned and free of all scale, rust, oil, paraffin or grease, for a distance of not less than 25 millimeters from the welding edge.

(2) When the penstock is completely erected and ready for concreting, there shall be no lugs, cover plates, saddle or other devices welded to the steel shell, except where these form part of the permanent support of the penstock for concreting. All temporary lugs and devices welded to the outside of the shell shall be carefully removed and the welds dressed smooth and flush with the surrounding metal. Care shall be exercised in removing such attachments to prevent cutting, tearing or gouging into the metal of the shell. After concreting is completed, all internal bracings and devices welded to the inside of the shell shall be similarly removed and the inside dressed smooth and flush.

(3) All lugs, saddles or brackets which are welded to the penstock and which are to form part of the permanent or temporary support shall be made of the same plate material as the penstock and the welding shall meet all the requirements as set out herein.

(4) All weld joints shall be dressed smooth and the maximum reinforcement shall be 2 millimeters on the inside of the penstock. On the outside of the penstock, welds shall be dressed free of all flux and scale and smooth to the extent necessary to allow radiographic examination.

M.3.4 Tolerance

The completed pipeline shall conform to the dimensions shown on the drawings and to the tolerance specified herein. The tolerance of circumferential length of each section shall not exceed plus or minus 0.25 per cent of the nominal length for that section or 6 millimeters, whichever is smaller. The ends of cylindrical sections shall be within a tolerance of plus or minus 2 millimeters of the plane normal to the axis of the sections. Angles or bends shown on the approved drawings shall be within a tolerance of plus or minus 10 minutes of angle. Edges of adjoining plates, to be welded, shall match with a maximum allowable offset at any one point of 2 millimeters. The penstock shall be aligned so that its centerline is within plus or minus 5 millimeters of the true centerline as shown on the drawings. The tolerances above mentioned are exclusive of any allowance for shrinkage or distortion provided by the Contractor to compensate for the effects of welding.

M.4 SPARE PARTS

Spare parts specified in Schedule IIA and those to be recommended in Schedule IIB in Volume-II shall be furnished by the contractor duly.

M.5 TESTS AND INSPECTIONS

M.5.1 Mill Tests

The steel plates for the penstock shall pass the following mill tests in accordance with the requirements of ASTM A370 or JIS G0303 for each thickness and each quality :

(1) Tensile test
(2) Bend test
(3) V-notch charpy impact test
(4) Chemical analysis

Certified copies of mill test reports shall be furnished to the Engineer in triplicate as soon as possible after the tests are made. The results of the tests shall be in a form that provides means of determining compliance with the applicable specifications for the material tested. When requested, all tests or trials shall be made in the presence of the authorized Inspector appointed by the Engineer.

M.5.2 Radiographic Examination

All longitudinal and girth joints in the steel pipeline shall be 100 per cent radiographed throughout their entire length. Radiographs shall be in accordance with the requirements of

ASME Boiler and Pressure Vessel Code Section V, Section UW 51, Section V III (1) or JIS Z 3104 or equivalent and the acceptable criteria of the welds shall be over class 2. Objectionable defects in welds shall be chipped, or flame-or arc-gouged to show sound metal and the defects rewelded. Welds that have been repaired shall be 100 per cent radiographed again. The Contractor shall furnish all equipment, films and labors necessary to perform the radiographic examinations. All original films of the radiographs shall become the property of CRM.

The Contractor shall provide proper storage for his radiographs and shall store and preserve all radiographs of welding, whether the welding is accepted or rejected. All radiographs shall be identified and an identification drawing prepared.

M.5.3 Test of Welding Joints

All test plates made shall be stamped to indicate the welder and date welded. The Contractor shall furnish all test plates, equipment, apparatus, supplies, and labors required for the tests.

The size of welding test plates shall be 400 millimeters by 300 millimeters in minimum made up by two 400 millimeters by 150 millimeters plates by weld together.

The tests which are carried out on every plate thickness in accordance with the requirements of the approved standard shall be as follows:

(1) Two tensile tests transverse to the weld axis
(2) Two root bends
(3) Two face bends

M.5.4 Inspection

The steel penstock will be inspected by the Engineer for welding and surface imperfections, such as undercut welds, stamp, clamp or chisel marks, surface pitting in the plate and other similar surface irregularities. Faulty material and workmanship shall be made good by the Contractor to the Engineer's entire satisfaction.

M.6 INSTALLATION

M.6.1 General

The installation work shall include the transporting of the pipe sections from the site store pit to the place of installation, and the erection and welding of the pipe sections in accordance with the finally approved drawings and manuals.

The Contractor shall carefully proceed with installation works in accordance with the schedule and the instructions from the Engineer, as the installation of the penstock is required to keep pace with the progress of related works. Prior to installation, the Contractor shall prepare and submit a plan for the order, method and schedule of installation upon careful deliberation with other contractor(s) concerned, and shall obtain the approval of the Engineer.

M.6.2 Handling and Placing

In order to maintain the accuracy of roundness of the sections within the tolerance specified in Clause M.3.4, internal spiders shall be provided in the sections immediately upon completion of fabrication to prevent any deformation that may take place during transportation, installation and concreting.

External structural steel supports and facilities for anchorage shall be supplied and installed to prevent displacement or uplift of the pipe sections due to buoyancy or external force that may occur during placing of concrete.

M.6.3 Field Welding

Welding at the installation site shall be performed manually, according to the method as specified herein. Matching of field welding girth joints shall be carried out with spiders and tackweld jigs. In no case pipe sections shall be forcibly joined. During the welding operations, the centers and distances between edge preparations shall be maintained at their proper positions. Equipment for drying the welding rods shall be provided to ensure that the welders use dry welding rods at all times. Radiographic examination shall be applied to all field weldings in accordance with Clause M.5.2 herein.

M.6.4 Removal of Spiders

Spiders shall not be removed without the prior permission of the Engineer.

M.6.5 Installation of Expansion Joint

The steel penstock within the vicinity of the expansion joint shall be maintained with the out-of-round tolerance of the expansion joint and shall be smooth and clean to prevent any damage to the seal. The joints shall be checked and made watertight seal after the penstock is filled with water.

SUBSECTION - N

CONGUILLO INLET, OUTLET FACILITIES

N.1 GENERAL

N.1.1 Scope

This Subsection covers the design, manufacture, testing before shipment, transportation to the site, installation/erection, commissioning and performance tests at the site of the following:

(1) Two (2) vertical shaft, 1.4 m diameters cone sleeve type discharge controllable outlet valves, each complete with motor driven actuator with operation deck and stand, flange connection, embedded steel protector, local and remote control panels and all other necessary accessories for their satisfactory and efficient operation.

(2) Four (4) sets of 1.4 m diameters and two (2) sets of 0.8 m diameter manual drive butterfly valve type guard valves, each pair complete with manual drive actuator, loose flange connection, by-pass system, operation deck and stand, and all other necessary accessories for their satisfactory and efficient operation.

(3) Two (2) lanes of 1.4 m diameters and one (1) lane of 0.8 m diameter steel pipe, each complete with flange connection, air vent valve, seepage and thrust rings, enlarging pipes and all other necessary accessories.

(4) Each one (1) set of drain pump and piping, float and throw-in type water level detectors/transmitters/indicators and all other necessary accessories.

(5) One (1) 20 kVA portable diesel engine generator set with trailer, panel and all other necessary accessories for proper and efficient operation.

The details of the equipment not specified herein, will be left to the Contractor, but subject to approval of the Engineer.

The arrangement of the equipment shall be as shown on the Drawings for Tender, Nos. 3-II-001 and 3-II-002.

N.1.2 Levels and Heads

(1) Water levels in the Daule-Peripa Reservoir (Conguillo River Course) and diversion tunnel inlet.

- Flood water level (FWL) : EL. 88.0 m
- Normal high water (NHWL) : EL. 85.0 m
- Low water level (LWL) : EL. 60.0 m
- Inlet sill level : EL. 66.0 m
- Low diversion water level (LDWL) : EL. 76.6 m for $Q_{max.}$=18.0 m^3/s/2 units
- Lowest diversion water level : EL. 66.6 m for Q = 0.0 m^3/s
- Diversion water level at Inlet (DWL): EL. 69.006 m at $Q_{max.}$=18.0 m^3/s

(2) Levels of pipe center

- 1.4 m diameters pipes : EL. 67.2 m
- 0.8 m diameter pipe : EL. 65.5 m

(3) Levels of the equipment to be installed

- Bottom of the embedded steel protector : EL. 55.631 m
- Bottom of drain pit : EL. 63.9 m
- Operation deck for manual drive actuator: EL. 70.231 m
- Operation deck for motor drive actuator : EL. 74.0 m
- Control room : EL. 90.2 m

N.1.3 Design Stresses

The allowable stresses for structural steel members and machine parts including concrete stresses shall conform to the requirements of Clause GS.6.1 of Part-I General Specifications and those in Subsections - L and - M respectively.

N.2 OUTLET VALVES

N.2.1 General

Two (2) discharge controllable cone sleeve type outlet valves in 1.4 m diameters shall be provided in the stilling well as shown on the attached Drawings for Tender. The valves shall be capable of controlling discharge water from zero up to $Q_{max.}$ = 18 m^3/s/2 units by

the motor drive actuators in accordance with the pre-determined Q-H curve upon receiving water levels information from the thrown-in and float type water level detectors which are provided in the reservoir and the stilling well respectively under the Contract. The valves shall be operated by AC motor drive actuators through either remote control panel or local control panel, and also by manual operating device when electric power failure or the controls and/or motor being out of order. Electric source is available by AC 220/127 V, 3-phases, 4-wires, 60 Hz.

N.2.2 Design Conditions

Each outlet valve shall be designed in accordance with those in Clauses N.1.2 and N.1.3, and given below:

(1)	Inner diameter	:	1.4 m
(2)	Max. discharge	:	Q = 18.0 $m^3/s/2$ units Between FWL 88.0 m and LDWL 76.6 m, while DWL at 69.006 m.
(3)	Operating range	:	Between FWL 88.0 m and the lowest DWL 66.6 m
(4)	Max. static head	:	32.369 m (FWL 88.0 m - Bottom EL. 55.631 m)
(5)	Test pressure	:	1.5 times the max. static head
(6)	Discharge coefficient	:	More than 0.7 (at full open)
(7)	Operation time	:	10 ~ 15 minutes (to be recommended)
(8)	Corrosion allowance	:	2 mm

N.2.3 Structural General

The valves shall conform to the following requirements.

(1) Each valve shall be of vertical type cone sleeve valve and shall consist of inlet elbow, riser pipe, valve body, inner sleeve, valve seat, embedded steel protector, spindle with protection pipe, electrically driven actuator with operation deck and stand, and all other necessary components.

(2) The inlet elbow made of stainless clad steel shall be connected with the main pipe by means of flange connection. The riser pipes shall be made of cast iron or approved material. Inner surface of the valve body shall be machine finished and then given chromium plating. Due grease piping shall be made for this contact surface. The inner sleeve, coned valve seat and the embedded steel protector shall be made of stainless steel and when closed, water leakage shall be kept within a reasonable value. The coned valve seat and protector shall be a close fit with the inner sleeve and capable of transferring all loads to the concrete structures. The spindle shall be

made of stainless steel and be connected with the inner sleeve and actuator with due bearings, supports, nuts, protection pipe, capping pipe, etc.

(3) The electrically driven actuator shall be provided on the operation deck and stand to raise and lower the inner sleeve. The position indicator to be readable in 1.0 cm shall be provided on each actuator and the remote control panel through the transmitter respectively. Fully opened and closed limit switches shall be provided on the actuator.

(4) The bottom and walls of the embedded steel protector under the corner baffle concrete of stilling well shall be protected by the stainless steel liners. It is noted that these parts shall be cast with concrete in situ in earlier time of construction. Gratings other than the space by operation decks will be provided by civil contractor.

N.2.4 Accessories

The following accessories shall be provided for each valve set by the Contractor.

(1) One complete set of anchor materials, bolts and nuts
(2) Necessary bolts and nuts for all connections
(3) One pair of position indicator including one set on the remote control panel and its transmitter.
(4) Limit switches for fully opened and fully closed valve positions
(5) Torque switches for opening and closing
(6) Other necessary accessories.

N.2.5 Spare Parts

The following spare parts shall be furnished by the Contractor, according to the Forms of Schedules in Volume-II.

(1) Two (2) grease nipples and/or cups of each type and size used
(2) One (1) set of fixed and moving contacts for switches, relays, etc.
(3) 100% of limit and torque switches
(4) Other necessary spare parts recommended by the manufacturer

N.3 GUARD VALVES

N.3.1 General

One (1) pair of manual drive butterfly type guard valves shall be provided for each two (2) 1.4 m diameters cone sleeve outlet valves and one (1) 0.8 m diameter steel outlet pipe respectively as shown on the attached Drawings for Tender. Each upstream side located valve shall be utilized to stop water during construction works, especially for steel pipes extending from the existing pipes and valves, and also utilized as the sub-guard valves against the downstream side main-guard valves because of no existence of inlet closing structure while Daule-Peripa reservoir water level can not lower beneath the inlet sill level at EL. 66.0 m even after completion of this inlet structure. The main guard valves in 1.4 m diameters shall be used for operation and maintenance of the cone sleeve outlet valves, while that in 0.8 m diameter as outlet valve to sweep off sand deposit in front of pipe inlets periodically and/or to supply water for cleaning inside of diversion tunnel, etc. All valves shall be used at either the fully opened or closed position for the purposes mentioned above.

N.3.2 Design Conditions

Each guard valve shall be designed in accordance with those in Clauses N.1.2 and N.1.3, and given below:

(1)	Inner diameter	:	1.4 m and 0.8 m
(2)	Discharging passing through valves	:	For 2 units in 1.4 m diameters: $Q_{max.} = 18\ m^3/s$ For 1 unit in 0.8 m diameter: $Q_{max.} = 3.5\ m^3/s$ at LDWL 76.6 m.
(3)	Operation range	:	For 1.4 m diameters, between FWL 88.0 m and the lowest DWL 66.6 m. For 0.8 m diameter, between LDWL 76.6 m and the valve center EL. 65.5 m.
(4)	Max. static head	:	20.8 m (FWL-Center EL.) for 1.4 m diameters 22.5 m (FWL-Center EL.) for 0.8 m diameter
(5)	Test pressure	:	1.5 times the max. static head
(6)	Operation time	:	Max. within 30 minutes (to be recommended)
(7)	Corrosion allowance	:	2 mm

N.3.3 Structural General

The valves shall conform to the following requirements.

(1) The valves shall be of manual drive butterfly valve type and shall consists of valve body, valve leaf, shaft, loose flange connection, by-pass system with manual valve

in 150 mm diameter, manual drive actuator with operation deck and stand and all other necessary components.

(2) Man-power on the manual handle shall be limited to less than 10 kgs/man.

(3) The valves shall be made of cast iron or other approved construction, having rubber-based seat for watertightness, and connected to main pipes with flange and loose flange connections.

(4) The valves shall at the fully opened and closed positions have the lockable mechanism so as to hold such positions for safety purposes. The valves shall be usually closed under the balanced head condition, but capable of shutting off full water flow when something happens at their downstream side structures.

(5) The position indicators to be readable in 1.0 cm shall be built in each valve actuator.

N.3.4 Accessories

The following accessories shall be provided on each valve set by the Contractor.

(1) One complete set of anchor materials, bolts and nuts
(2) Necessary bolts and nuts for all connections
(3) One (1) set of position indicator
(4) Other necessary accessories

N.3.5 Spare Parts

The following spare parts shall be furnished by the Contractor, according to the Forms of Schedules in Volume-II.

(1) Two (2) grease nipples and/or cups of each type and size used
(2) One (1) set of seal with clamping and fixing screws and plate for each valve
(3) Other necessary spare parts recommended by the manufacturer

N.4 STEEL PIPES

N.4.1 General

Three (3) lanes of steel pipes in 1.2 m and 0.8 m diameters with stop valves and blind covers, locating in the vicinity of inlet structure, vide the attached Drawings for Tender had been provided in 1990's by others.

Therefore the Contractor shall provide steel pipes downstream from the companion flange of the existing stop valves in 1.2 m and 0.8 m diameters upon removing the blind covers. The Contractor shall inspect himself the boundary points and provide due extra pipe lengths for connecting purposes.

The steel pipes to be made of stainless clad steel to resist for long with silt or sand laded water shall have inner diameters in 1.2 m to 1.4 m and 0.8 m respectively, and shall consist of straight pipes, enlarging pipes in 1.2 m to 1.4 m diameters, bend pipes, flange and loose flange connections, air vent valves, seepage and thrust rings, and all other necessary accessories. Most of steel pipes locating inside tunnel will be cast in situ concrete of other contractor in earlier construction stage.

N.4.2 Design Conditions

Each steel pipe shall be designed in accordance with those in Clauses N.1.2 and N1.3, and given below:

(1)	Inner diameter:	:	1.2 m to 1.4 m and 0.8 m
(2)	Design internal and external pressures (at embedded parts)	:	20.8 m for 1.2/1.4 m diameters portion, and 22.5 m for 0.8 m diameter portion.
(3)	Other external pressures	:	3.0 kgf/cm^2 as grouting pressure, and 0.2 kgf/cm^2 (to be avoided by air vent valve) at the exposed portion.
(4)	Corrosion allowance	:	2 mm

N.4.3 Structural General

The steel pipes shall conform to the following requirements.

(1) The steel pipes shall be made of stainless clad steel, facing the clad part to water flow side; the strength of which shall be ignored for stress calculation. The parent steel material shall conform to ASTM A516 Grade 60/70 or JIS G 3106 SM400 B/490 B.

(2) The steel pipes where encased in concrete and where located at the exposed portion shall be capable of resisting the given external pressures when inside of them empty, and head difference of 0.2 kgf/cm^2 between inside and outside of pipe respectively.

(3) Minimum thickness of shell plate shall not be less than 6 mm considering handling during fabrication, transportation and field erection.

(4) Full penetration butt-weld joint shall be employed throughout all longitudinal and girth welds in the steel pipes. The strength of such welds shall be rated at 90% of the parent steel plate strength. All weld joints in longitudinal and girth directions shall be examined their completeness with 100% radiographic inspection.

(5) The loose flange shall consist of flange, rubber ring, bolts, nuts and all other necessary components. The flanges shall be made of either mild steel or cast iron.

N.4.4 Accessories

The following accessories shall be provided by the Contractor.

(1) One complete set of installation jigs, anchor materials, etc.
(2) Necessary bolts, nuts, washers and gaskets for flange connections.
(3) All welding rods and X-ray films required for the works
(4) Other necessary accessories

N.4.5 Spare Parts

The following spare parts shall be furnished by the Contractor, according to the Forms of Schedules in Volume-II.

(1) One (1) set of gasket of each type for pipe connections
(2) Other necessary spare parts recommended by the manufacturer

N.5 DRAIN PUMP AND WATER LEVEL DETECTORS

N.5.1 General

Each one (1) set of drain pump and piping, float and throw-in type water level detector/transmitter/indicator and all other necessary accessories shall be provided in the inlet structure to drain water in the sump pit and stilling well, and to assist discharge water control by the outlet valves. Electric source is available by AC 220/127 V, 3-phases, 4-wires, 60 Hz.

N.5.2 Design Conditions

Each equipment shall be designed in accordance with those in Clauses N.1.2 and N.1.3 and given below:

(1) Drain pump

- Sump pit size : 1.5 m square in plan by 1.0 m depth
- Pit bottom : EL. 63.9 m
- Pipe outlet : EL. 70.8 m
- Pump capacity : 0.15 m^3/min. by 50 mm diameter at a head of 10.0 m
- Control : By manual "start" and "stop" with automatic stop switch at LWL in the pit. Their controls shall be incorporated into the local control panel at EL. 74.0 m.
- Piping and Accessories : One complete piping, hose and accessories required for proper operation.

(2) Throw-in type water level detector/transmitter/indicator.

- Setting location : At a point in the reservoir in the vicinity of inlet trash boom.
- Measuring range : Between FWL 88.0 m and the lowest DWL 66.6 m.
- Accuracy : Less than 2.0% against 5.0 cm to be read
- Transmitting distance : Approx. 100.0 m (to be decided with actual site location).
- Water level indicator : On the remote control panel in the control room at EL.90.2 m.
- Accessories : Special power and control cables, and other fittings between water level detector and remote control panel, along with joint box(es) where appropriate, which are required for proper detection.

(3) Float type water level detector/transmitter/indicator

- Setting location : In the stilling well
- Measuring range : Between water level at EL.73.0 m and 66.0 m
- Accuracy : Less than 2.0% against 5.0 cm to be read

- Water level indicators : Each one (1) set on the water level detecting device and remote control panel in the control room at EL.90.2 m.
- Accessories : All power and control cables, and other fittings between water level detecting device and remote control panel, which are required for proper detection.

N.5.3 Spare Parts

The following spare parts shall be furnished by the Contractor, according to the Forms of Schedules in Volume-II.

(1) One (1) set of spare parts recommended by the manufacturer.

N.6 DIESEL ENGINE GENERATOR SET

N.6.1 General

One (1) 20 kVA portable diesel engine generator set shall be provided to supply normal electric power for operation of outlet valves, drain pump, water level detectors, and other contractor's roof ventilators, lighting and so forth whenever operation of the equipment requires at the inlet structure. The generator will also be made available for other purpose in the vicinity of the inlet structure.

The portable diesel engine generator set shall comprise diesel engine, generator, trailer, panel and all other necessary accessories for the proper and efficient operation. The generator set will be normally stored in the control room and operated at outside open air, connecting power cable to a switch panel of other contractor located inside control room.

N.6.2 Diesel Engine

The diesel engine shall be of four-cycle, multi-cylinder, water-cooled radiator type with lubricating oil system, fuel oil supply system and automatic starting system by a starting motor and both automatically and manually stopping system.

The rated output of the diesel engine generator shall be guaranteed to be 16 kW at the generator terminal under the specified climatic conditions at the Site.

The diesel engine shall mount the D.C. batteries of sealed type with an ample capacity starting.

The diesel engine shall be provided with the following accessories:

- One (1) fuel oil tank with suitable level gauge and its supporting structure for gravity oil feed to the engine.
- One (1) fuel oil injection pump
- One (1) set of fuel oil filter
- One (1) set of flexible fuel line
- One (1) radiator with fan
- One (1) thermometer for cooling water
- One (1) set of silencer and exhaust pipe
- One (1) set of maintenance tool set with a lockable steel box
- Other accessories of the manufacturer's standard

N.6.3 Generator

The generator shall be of synchronous alternator in 220/127V, 3-phases, 4-wires, 60 Hz with brushless exciter and be directly connected to the diesel engine. The A.C. exciter shall be three-phases, air-cooled, rotating armature type generator to feed direct current to the main generator field. The A.C. exciter shall be coupled directly with the main generator shaft on the opposite end of the engine.

The generator shall be provided with the following accessories:

- 150% of the quantity of lubricating oil
- Rating plate
- Special tools
- Power supply cable in approx. 20 m
- Other necessary accessories of the manufacturer's standard

N.6.4 Trailer

The trailer shall be provided with 4 pneumatic tired wheels, suspensions, storing devices, a folding drawbar and parking brakes.

The all parts except for the silencer and exhaust pipe shall be suitably enclosed by the steel plate on the trailer.

N.6.5 Panel

The generator shall be provided with the control panel. The following instruments shall be mounted on the panel, but shall not be limited to:

- One (1) starter switch
- One (1) speed controller
- One (1) tachometer
- One (1) fuel oil level gauge
- One (1) oil pressure gauge
- One (1) cooling water temperature gauge
- One (1) A.C. ammeter
- One (1) A.C. voltmeter
- One (1) wattmeter
- One (1) frequency meter
- One (1) alarms and indicating systems for safety operation
- One (1) molded case circuit breaker
- Other necessary instruments of the manufacturer's standard

N.6.6 Spare Parts

The following spare parts shall be furnished by the Contractor, according to the Forms of Schedules in Volume-II.

(1) One (1) set of spare parts recommended by the manufacturer

N.7 CONTROL SYSTEM AND CONTROLS

N.7.1 General

Water discharging from outlet valves shall be controlled at a rate of valve opening in percentage in accordance with the pre-determined Q-H curve upon obtaining water levels information from the throw-in and float type water level detectors which are provided in the reservoir and the stilling well respectively under the Contract.

N.7.2 Control System

The outlet valves shall be operated in normal case in the following order, with the push-button controls mounted on the remote and/or local control panels, upon changing a selector switch to choose priority order of operation at the local control panel side.

(1) Opening sequence

- Condition : Outlet and main guard valves at the fully closed positions
- Fill water by opening by-pass valve to equalize water pressure
- Close by-pass valve
- Open fully the main guard valve
- Open outlet valve slightly to first fill water in the stilling well, and then regulate water discharge.

(2) Closing sequence

- Close outlet valve fully
- Close main guard valve fully

N.7.3 Electric Source and Wiring

Electric source is available by AC 220/127 V, 3-phases, 4-wires, 60 Hz at a switch panel of other contractor located inside control room, through a portable diesel engine generator set in Clause N.6. The Contractor shall furnish all power cables from this boundary point to each control panel, and the secondary power and control cables and/or wires with fittings which are necessary for the required operation of the requirement and controls supplied under the Contract.

N.7.4 Control Panels

The Contractor shall provide self-standing type one (1) remote control panel inside control room at EL.90.2 m and one (1) local control panel near the actuators of outlet valves at EL. 74.0 m for operation of the outlet valves, drain pump, water level detectors/transmitters/ indicators.

The panels shall be of weather proof construction, completely enclosed, with keyed access doors and/or windows, assembled using angle or channel members, seam-welded at the corners and finished smooth. All necessary switches, indicators, relays, transformers, no-fuse breakers, volt meters, ampere meters, pilot lights, indicating lights, starters for motors, convenience outlets, contactors, miscellaneous wiring components and so forth shall be

installed inside the panels. All indicators such as valve position indicators, water level indicators, meters and lights shall be visible from outside without opening the keyed doors or windows. Anti-moisture heaters shall be mounted on due equipment and panels. Push-button switches for outlet valves (for open, close and stop) shall be provided on both panels, while start and stop push-button switches (inclusive of automatic stop switch) for drain pump on the local control panel only.

N.8 SHOP ASSEMBLY AND TEST

N.8.1 Outlet Valves, Guard Valves, Steel Pipes and Other Associated Equipment

The outlet and guard valves shall be completely shop assembled and tested for smooth and proper performance. All units shall be tested in important materials, dimensions, hydrostatically, and at normal operating speed and the rated load, and closely checked to ensure that all necessary clearances and tolerances have been provided and that no binding occurs in any moving part. All bearings shall be carefully checked. All lubricating grease and oil required for the performance of the test shall be furnished. An operation test between the remote and local controls shall be made upon electrically connecting the remote control panel and local control panel to the equipment and at the rated load condition to prove specified functions.

The following items shall at least be checked during the said operation test.

- Opening and closing speeds
- Voltage and current of electric motor
- Temperature rise of bearings, motor and gear reducer
- Existence of abnormal noise and vibration
- Manual operation of actuator
- Operation of limit and torque switches
- Accuracy of valve position indicator vs. actual valve opening
- Appearance and overall performance of control panel

Any defect or improper operation discovered shall be corrected and the entire test shall be repeated to the satisfaction of the Engineer.

Each unit steel pipes and accessories shall be checked for important materials, dimensions, tolerances specified, radiographic examination and so forth. Other associated equipment such as drain pump and water level detectors, etc. may be accepted upon confirming with the manufacturer's test records.

N.8.2 Portable Diesel Engine Generator Set

The portable generator shall be tested at the manufacturer's shop before shipment. The following items shall at least be checked during the operation test.

- Operation test (starting and stopping tests)
- Load test including temperature rise and fuel oil consumption measurement
- Overspeed test (120% for one minutes)
- Plotting of characteristics of the generator
- Efficiency test of the generator
- Test for control panel, including relay test and meter calibration check

N.9 INSTALLATION

N.9.1 Valves and Steel Pipes

The embedded steel protectors of outlet valves shall be assembled at place firstly so as to cast with in situ concrete. Other equipment are installed with anchor bars provided in the first and blockout concrete. Steel pipes are transported in sections to installation site from storage yard for installation, welding, inspection and so forth. All works shall be in accordance with the For-Work-Drawings and approved installation manual, 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 equipment at corresponding accurate position.

Connections between the equipment, anchor materials and the alignment devices shall be adjustable and firmly tightened to hold them securely in position while concrete is being placed in. Additional bracings shall be provided where necessary to ensure the required alignment. Placement of concrete shall not proceed until the equipment have been completely assembled and secured. After concrete placing, alignment and tolerances shall be checked and remedial action taken if readings indicate that displacement has occurred.

N.9.2 Actuators

Before installation, all bearing surfaces, journals and grease and oil grooves shall be carefully checked and lubricated with an approved oil or grease, where necessary.

The actuators complete with all accessories, shall be installed in accordance with the For-Work-Drawings and approved installation manual for erection works. The actuators shall be located and adjusted so that they are in true alignment with the center of the valves.

After installation, the actuators shall be operated and checked for proper operation, at which time all controls such as limit switches and position indicator, etc., shall be adjusted fully and tested for proper operation.

N.9.3 Portable generator

The Contractor shall bring the portable generator to the inlet structure and connect the power cable to the switch panel located inside control room. After connection of the power cable, the generator shall be operated and checked fully for proper operation.

N.9.4 Tests on Completion

After completion of the installation works and their adjustments at the Site, the tests shall be performed by the Contractor in accordance with the approved test procedure, vide Clause GS.11 of Part-I General Specifications. Any defect or improper operation discovered during the test shall be corrected and the entire test shall be repeated up to the satisfaction of the Engineer.

SUBSECTION - O

POZA HONDA INLET, OUTLET FACILITIES

O.1 GENERAL

O.1.1 Scope

This Subsection covers the design, manufacture, testing before shipment, transportation to the site, installation/erection, commissioning and performance tests at the site of the following:

(1) One (1) complete set of inlet fixed trashrack with support beams, covering an opening of 4.1 m vertical high and 4.0 m wide.

(2) Two (2) vertical shaft, 0.9 m diameter cone sleeve type discharge controllable outlet valves, each complete with motor driven actuator with operation deck and stand, flange connection, embedded steel protector, local and remote control panels and all other necessary accessories for their satisfactory and efficient operation.

(3) Two (2) sets of 0.9 m diameter manual drive butterfly valve type guard valve, each complete with manual drive actuator, loose flange connection, by-pass system, operation deck and stand, and all other necessary accessories for their satisfactory and efficient operation.

(4) Two (2) lanes of 0.9 m diameter steel pipe, each complete with flange connection, air vent valve, seepage and thrust rings, bellmouth pipes and all other necessary accessories.

(5) Each one (1) set of drain pump and piping, float and throw-in type water level detectors/transmitters/indicators and all other necessary accessories.

(6) One (1) 20 KVA portable diesel engine generator set with trailer, panel and all other necessary accessories for proper and efficient operation.

The details of the equipment not specified herein, will be left to the Contractor, but subject to approval of the Engineer.

The arrangement of the equipment shall be as shown on the drawings for Tender, Nos. 3-III-001 and 3-III-002.

O.1.2 Levels and Heads

(1) Water levels in the Poza Honda Reservoir and diversion tunnel inlet.

- Flood water level (FWL) : EL. 110.3 m
- Normal high water (NHWL) : EL. 106.5 m
- Low water level (LWL) : EL. 88.3 m
- Inlet sill level : EL. 90.9 m
- Low diversion water level (LDWL) : EL. 94.0 m for $Q_{max.}$=4.0 m^3/s/2 units
- Lowest diversion water level : EL. 91.4 m for Q = 0.0 m^3/s
- Diversion water level at Inlet (DWL) : EL. 92.063 m at $Q_{max.}$=4.0 m^3/s

(2) Levels of pipe center

- 0.9 m diameter pipes : EL. 90.8 m

(3) Levels of the equipment to be installed

- Bottom of the embedded steel protector : EL. 82.45 m
- Bottom of drain pit : EL. 88.80 m
- Operation deck for manual drive actuator: EL. 93.05 m
- Operation deck for motor drive actuator : EL. 95.50 m
- Control room : EL. 112.5 m

O.1.3 Design Stresses

The allowable stresses for structural steel members and machine parts including concrete stresses shall conform to the requirements of Clause GS.6.1 of Part-I General Specifications and those in Subsections -L and -M respectively.

O.2 INLET FIXED TRASHRACK

O.2.1 General

One (1) set of the fixed type trashrack shall be provided for the Poza Honda Inlet Structure. The trashrack shall be designed to prevent matter, injurious to the outlet valves, from entering the inlet opening and to adequately withstand the impact forces, static load and vibration phenomena which are likely to occur due to flow of water passing through the trashrack in 4.0 m^3/sec. The trashrack shall be 4.0 m wide by 4.1 m high and the arrangement of the trashrack shall be as shown on the Drawing for Tender.

O.2.2 Design Conditions

The trashrack shall be designed in accordance with those in Clauses O.1.2 and O.1.3, and given below:

(1) The water load on a bar element shall be 2.25 kg/cm of length applied on the edge of the bar element.

(2) The trashrack shall be free from vibration under the given design conditions.

(3) The following loads shall be considered for design of support beams.

i) The reaction load due to water force on the bar elements.

ii) The load due to self-weight.

(4) In addition to the requirements in Clause O.1.3, the bar elements shall meet the following requirements that the stress in the bar elements shall not exceed the following critical stress.

$$\text{Critical allowable stress} = 0.6 \times \text{yielding stress} \left(1.23 - 0.0153 \frac{L}{t}\right)$$

where; L : Laterally supported length of bar element in cm, $L < 70\,t$

t : Thickness of the bar in cm (not considering corrosion allowance).

Note: The thickness of the bar element shall be increased by 2.0 millimeters as corrosion allowance to the calculated thickness.

O.2.3 Structural General

The trashrack shall conform to the following requirements,

(1) The trashrack shall consist of bar elements, support beams, and all other necessary components. The details of the construction of the trashracks not specified herein, will be left to the Contractor, but subject to approval of the Engineer. The trashrack panels shall be fixed on the support beams by using the stainless steel bolts, nuts and washers.

(2) The bar elements of the trashrack shall be of rectangular section, and minimum thickness of the bars shall not be less than 10 millimeters. The center-to-center distance of the bar elements (pitch) shall be kept in 75 millimeters plus or minus 2 millimeters by distance pieces. All bars shall be formed into several panels by tie

rods made of stainless steel to suit to the stainless steel fixing bolts, nuts and washers, and then fixed on the support beams forcibly to prevent vibration.

(3) The support beams shall be of H-beam or built-up steel construction, and all or both ends of beams shall be embedded in the concrete. The maximum deflection of the support beams shall be less than 1/600 of the clear span.

O.2.4 Spare Parts

The following spare parts shall be furnished by the Contractor, according to the Forms of Schedules in Volume-II.

(1) One (1) set of spare parts recommended by the manufacturer.

O.3 OUTLET VALVES

O.3.1 General

Two (2) discharge controllable cone sleeve type outlet valves in 0.9 m diameter shall be provided in the stilling well as shown on the attached Drawings for Tender. The valves shall be capable of controlling discharge water from zero up to $Q_{max.}$ = 4.0 $m^3/s/2$ units by the motor drive actuators in accordance with the pre-determined Q-H curve upon receiving water levels information from the thrown-in and float type water level detectors which are provided in the reservoir and the stilling well respectively under the Contract. The valves shall be operated by AC motor drive actuators through either remote control panel or local control panel, and also by manual operating device when electric power failure or the controls and/or motor being out of order. Electric source is available by AC 220/127 V, 3-phases, 4-wires, 60 Hz.

O.3.2 Design Conditions

Each outlet valve shall be designed in accordance with those in Clauses O.1.2 and O.1.3, and given below:

(1)	Inner diameter	:	0.9 m
(2)	Max. discharge	:	Q =4.0 $m^3/s/2$ units between FWL 110.3 m and LDWL 94.0 m, while DWL at 92.063 m.
(3)	Operating range	:	Between FWL 110.3 m and the lowest DWL 91.4 m
(4)	Max. static head	:	21.85 m (FWL 110.3 m - Bottom EL. 82.45 m)
(5)	Test pressure	:	1.5 times the max. static head
(6)	Discharge coefficient	:	More than 0.7 (at full open)

(7) Operation time : Approx. 10 minutes (to be recommended)

(8) Corrosion allowance : 2 mm

O.3.3 Structural General

The valve details shall conform to the requirements mentioned in Clause N.2.3 herein.

O.3.4 Accessories

The following accessories shall be provided for each valve set by the Contractor.

(1) One complete set of anchor materials, bolts and nuts

(2) Necessary bolts and nuts for all connections

(3) One pair of position indicator including one set on the remote control panel and its transmitter.

(4) Limit switches for fully opened and fully closed valve positions

(5) Torque switches for opening and closing

(6) Other necessary accessories.

O.3.5 Spare Parts

The following spare parts shall be furnished by the Contractor, according to the Forms of Schedule in Volume-II.

(1) Two (2) grease nipples and/or cups of each type and size used

(2) One (1) set of fixed and moving contacts for switches, relays, etc.

(3) 100% of limit and torque switches

(4) Other necessary spare parts recommended by the manufacturer

O.4 GUARD VALVES

O.4.1 General

Two (2) sets of 0.9 m diameter, manual drive butterfly type guard valves shall be provided for two (2) 0.9 m diameter cone sleeve outlet valves as shown on the attached Drawings for Tender. The guard valves shall be used at either the fully opened or closed position for operation and maintenance purposes of the outlet valves.

O.4.2 Design Conditions

Each guard valve shall be designed in accordance with those in Clauses O.1.2 and O.1.3, and given below:

(1)	Inner diameter:	:	0.9 m
(2)	Discharging passing through valves	:	$Q_{max.} = 4.0\ m^3/s/2$ units
(3)	Operation range	:	Between FWL 110.3 m and the lowest DWL 91.4 m..
(4)	Max. static head	:	19.5 m (FWL-Center EL.)
(5)	Test pressure	:	1.5 times the max. static head
(6)	Operation time	:	Max. within 30 minutes (to be recommended)
(7)	Corrosion allowance	:	2 mm

O.4.3 Structural General

The valve details shall conform to the requirements mentioned in Clause N.3.3 herein.

O.4.4 Accessories

The following accessories shall be provided on each valve set by the Contractor.

(1) One complete set of anchor materials, bolts and nuts
(2) Necessary bolts and nuts for all connections
(3) One (1) set of position indicator
(4) Other necessary accessories

O.4.5 Spare Parts

The following spare parts shall be furnished by the Contractor, according to the Forms of Schedules in Volume-II.

(1) Two (2) grease nipples and/or cups of each type and size used
(2) One (1) set of seal with clamping and fixing screws and plate for each valve
(3) Other necessary spare parts recommended by the manufacturer

O.5 STEEL PIPES

O.5.1 General

The Contractor shall provide steel pipes from the contract boundary to each valve. The steel pipes to be made of stainless clad steel to resist for long with silt or sand laded water shall have inner diameter in 0.9 m, and shall consist of straight pipes, bellmouth pipes, bend pipes, flange and loose flange connections, air vent valves, seepage and thrust rings, and all other necessary accessories. Most of steel pipes locating inside tunnel will be cast in situ concrete of other contractor in earlier construction stage.

O.5.2 Design Conditions

Each steel pipe shall be designed in accordance with those in Clauses O.1.2 and O.1.3, and given below:

(1)	Inner diameter:	:	0.9 m
(2)	Design internal and external pressures (at embedded parts)	:	19.5 m
(3)	Other external pressures	:	3.0 kgf/cm^2 as grouting pressure, and 0.2 kgf/cm^2 (to be avoided by air vent valve) at the exposed portion.
(4)	Corrosion allowance	:	2 mm

O.5.3 Structural General

The steel pipe details shall conform to the requirements mentioned in Clause N.4.3.

O.5.4 Accessories

The following accessories shall be provided by the Contractor.

(1) One complete set of installation jigs, anchor materials, etc.
(2) Necessary bolts, nuts, washers and gaskets for flange connections.
(3) All welding rods and X-ray films required for the works
(4) Other necessary accessories

O.5.5 Spare Parts

The following spare parts shall be furnished by the Contractor, according to the Forms of Schedules in Volume-II.

(1) One (1) set of gasket of each type for pipe connections

(2) Other necessary spare parts recommended by the manufacturer

O.6 DRAIN PUMP AND WATER LEVEL DETECTORS

O.6.1 General

Each one (1) set of drain pump and piping, float and throw-in type water level detector/transmitter/indicator and all other necessary accessories shall be provided in the inlet structure to drain water in the sump pit and stilling well, and to assist discharge water control by the outlet valves. Electric source is available by AC 220/127 V, 3-phases, 4-wires, 60 Hz.

O.6.2 Design Conditions

Each equipment shall be designed in accordance with those in Clauses O.1.2 and O.1.3, and given below:

(1) Drain pump

- Sump pit size	:	1.0 m square in plan by 1.0 m depth
- Pit bottom	:	EL. 88.8 m
- Pipe outlet	:	EL. 93.11 m
- Pump capacity	:	0.15 m^3/min. by 50 mm diameter at a head of 10.0 m.
- Control	:	By manual "start" and "stop" with automatic stop switch at LWL in the pit. Their controls shall be incorporated into the local control panel at EL. 95.5 m.
- Piping and Accessories	:	One complete piping, hose and accessories required for proper operation.

(2) Throw-in type water level detector/transmitter/indicator.

- Setting location : At a point in the reservoir in the vicinity of inlet trash boom.
- Measuring range : Between FWL 110.3 m and the lowest DWL 91.4 m.
- Accuracy : Less than 2.0% against 5.0 cm to be read
- Transmitting distance : Approx. 100.0 m (to be decided with actual site location).
- Water level indicator : On the remote control panel in the control room at EL.112.5 m.
- Accessories : Special power and control cables, and other fittings between water level detector and remote control panel, along with joint box(es) where appropriate, which are required for proper detection.

(3) Float type water level detector/transmitter/indicator

- Setting location : In the stilling well
- Measuring range : Between water level at EL.94.5 m and 90.0 m
- Accuracy : Less than 2.0% against 5.0 cm to be read
- Water level indicators : Each one (1) set on the water level detecting device and remote control panel in the control room at EL.112.5 m.
- Accessories : All power and control cables, and other fittings between water level detecting device and remote control panel, which are required for proper detection.

O.6.3 Spare Parts

The following spare parts shall be furnished by the Contractor, according to the Forms of Schedules in Volume-II.

(1) One (1) set of spare parts recommended by the manufacturer.

O.7 DIESEL ENGINE GENERATOR SET

O.7.1 General

One (1) 20 kVA portable diesel engine generator set shall be provided to supply normal electric power for operation of outlet valves, drain pump, water level detectors, and other contractor's roof ventilators, lighting and so forth whenever operation of the equipment requires at the inlet structure. The generator will also be made available for other purpose in the vicinity of the inlet structure.

The portable diesel engine generator set shall comprise diesel engine, generator, trailer, panel and all other necessary accessories for the proper and efficient operation. The generator set will be normally stored in the control room and operated at outside open air, connecting power cable to a switch panel of other contractor located inside control room.

O.7.2 Structural General

The diesel engine generator set details shall conform to the requirements mentioned in Clauses N.6.2 to N.6.5 herein, except that the rated output of diesel engine generator is to be 16 kW at the generator terminal.

O.7.3 Spare Parts

The following spare parts shall be furnished by the Contractor, according to the Forms of Schedules in Volume-II.

(1) One (1) set of spare parts recommended by the manufacturer.

O.8 CONTROL SYSTEM AND CONTROLS

O.8.1 General

Water discharging from outlet valves shall be controlled at a rate of valve opening in percentage in accordance with the pre-determined Q-H curve upon obtaining water levels information from the throw-in and float type water level detectors which are provided in the reservoir and the stilling well respectively under the Contract.

O.8.2 Control System

The outlet valves shall be operated in normal case in the following order, with the push-button controls mounted on the remote and/or local control panels, upon changing a selector switch to choose priority order of operation at the local control panel side.

(1) Opening sequence

- Condition : Outlet and guard valves at the fully closed positions
- Fill water by opening by-pass valve to equalize water pressure
- Close by-pass valve
- Open fully the guard valve
- Open outlet valve slightly to first fill water in the stilling well, and then regulate water discharge.

(2) Closing sequence

- Close outlet valve fully
- Close guard valve fully

O.8.3 Electric Source and Wiring

Electric source is available by AC 220/127 V, 3-phases, 4-wires, 60 Hz at a switch panel of other contractor located inside control room, through a portable diesel engine generator set in Clause O.7. The Contractor shall furnish all power cables from this boundary point to each control panel, and the secondary power and control cables and/or wires with fittings which are necessary for the required operation of the requirement and controls supplied under the Contract.

O.8.4 Control Panels

The Contractor shall provide self-standing type one (1) remote control panel inside control room at EL.112.5 m and one (1) local control panel near the actuators of outlet valves at EL. 95.5 m for operation of the outlet valves, drain pump, water level detectors/ transmitters/ indicators.

The panels shall be of weather proof construction, completely enclosed, with keyed access doors and/or windows, assembled using angle or channel members, seam-welded at the corners and finished smooth. All necessary switches, indicators, relays, transformers, no-fuse breakers, volt meters, ampere meters, pilot lights, indicating lights, starters for motors, convenience outlets, contactors, miscellaneous wiring components and so forth shall be installed inside the panels. All indicators such as valve position indicators, water level indicators, meters and lights shall be visible from outside without opening the keyed doors or windows. Anti-moisture heaters shall be mounted on due equipment and panels. Push-button switches for outlet valves (for open, close and stop) shall be provided on both panels, while start and stop push-button switches (inclusive of automatic stop switch) for drain pump on the local control panel only.

O.9 SHOP ASSEMBLY AND TEST

O.9.1 Outlet Valves, Guard Valves, Trashrack, Steel Pipes and Other Associated Equipment

The outlet and guard valves shall be completely shop assembled and tested for smooth and proper performance. All units shall be tested in important materials, dimensions, hydrostatically, and at normal operating speed and the rated load, and closely checked to ensure that all necessary clearances and tolerances have been provided and that no binding occurs in any moving part. All bearings shall be carefully checked. All lubricating grease and oil required for the performance of the test shall be furnished. An operation test between the remote and local controls shall be made upon electrically connecting the remote control panel and local control panel to the equipment and at the rated load condition to prove specified functions.

The following items shall at least be checked during the said operation test.

- Opening and closing speeds
- Voltage and current of electric motor
- Temperature rise of bearings, motor and gear reducer
- Existence of abnormal noise and vibration
- Manual operation of actuator
- Operation of limit and torque switches
- Accuracy of valve position indicator vs. actual valve opening
- Appearance and overall performance of control panel

Any defect or improper operation discovered shall be corrected and the entire test shall be repeated to the satisfaction of the Engineer.

Each unit steel pipes, trashrack and accessories shall be checked for important materials, dimensions, tolerances specified, radiographic examination and so forth. Other associated equipment such as drain pump and water level detectors, etc. may be accepted upon confirming with the manufacturer's test records.

O.9.2 Portable Diesel Engine Generator Set

The portable generator shall be tested at the manufacturer's shop before shipment. The following items shall at least be checked during the operation test.

- Operation test (starting and stopping tests)
- Load test including temperature rise and fuel oil consumption measurement
- Overspeed test (120% for one minutes)

- Plotting of characteristics of the generator
- Efficiency test of the generator
- Test for control panel, including relay test and meter calibration check

O.10 INSTALLATION

O.10.1 Installation/Erection

The requirements for installation and erection of the equipment shall conform to those specified in Clause N.9 herein.

O.10.2 Tests on Completion

After completion of the installation/erection works and their adjustments at the Site, the tests shall be performed by the Contractor in accordance with the approved test procedure, vide Clause GS.11 of Part-I General Specifications. Any defect or improper operation discovered during the test shall be corrected and the entire test shall be repeated up to the satisfaction of the Engineer.

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