T7.3 Instruction Manuals

T7.3.1 Operating and maintenance instructions

The Contractor shall submit to the PMO/Engineer the general instructions describing the correct manner of operation and maintenance of all the Plant provided under this Chapter with special references to any recently developed features.

The instruction manual shall be prepared for each item as outlined in sub-clause T7.1.1 "Scope of works", and shall be submitted for approval in the same manner as the drawings. It shall be finalized and be submitted as "FOR WORK DRAWINGS" before delivery of the Plant to the Site. Within one (1) month upon Completion of the Works provided under this Chapter, five (5) copies and two (2) copies shall be submitted to the Employer and the PMO/Engineer accordingly as the "Final drawings and documents" in sub-clause T7.2.4, respectively.

The instruction manual shall include a separable and complete section describing the normal and emergency operating procedures for the control of the Plant, and shall include easily read diagrammatic drawings of such operating procedures to facilitate understanding of the descriptive information.

The instruction manual shall describe and illustrate in detail the method and procedure for assembling, adjusting, operating and dismantling of each component, system and machine and the use of equipment devices necessary for such works. The maintenance manual shall describe on the routine inspection items of each component and lubrication with recommended frequency of such work. Possible symptoms which indicate unsound condition of each component vs. permissible criteria thereof and required countermeasures therefore shall also be included in the manual.

The Contractor shall, in preparing the instruction manual, take into account the lack of experience and familiarity of the operating personnel with this type of equipment.

The manual shall also include a complete list of all drawings prepared for the Plant in this Chapter, the approved painting specifications, the tool list, the spare parts list, the parts list for each component of item of equipment with necessary catalogues, etc. The parts list shall include manufacturer's code and serial numbers and ordering instructions. The parts list shall be detailed for only the equipment supplied and shall not include general reference or description of similar equipment which is of the same model but different only in detail.

T7.3.2 Instructions for erection works

The Contractor shall submit to the PMO/Engineer for approval the instruction manual for the erection work of the Plant to be executed at the Site.

The instruction manual shall be submitted for approval in the same manner as the drawings and, three (3) copies shall be submitted to the Employer and two (2) copies to the PMO/Engineer as "FOR WORK DRAWINGS" before delivery of the Plant to the Site. The Contractor shall ensure that the erection supervisor has a copy in his office at the Site.

The instruction manual shall describe and illustrate in detail the methods and procedures for installation of the Plant, the use of the construction facilities and measurement devices together with their capacity and required number, field shop to be provided for the installation work and other necessary explanations on the installation work.

T7.3.3 Test procedure instructions

The Contractor shall submit to the PMO/Engineer for approval, during or immediately following the submission of drawings, the instructional test procedures, describing each test to be performed at the Contractor's shop and at the Site within the time mentioned in Clause T7.2 "Drawings and Documents to be Supplied by the Contractor". The test procedures shall define the sequence of the tests, the equipment preparation and operation procedures to be followed and the detailed procedures for conducting the tests, tolerances for dimension and/or quality controls and other necessary items for the tests. The test procedures shall be separately prepared for the tests to be performed at the shop and at the Site. These procedures shall be submitted and distributed in the same manner as the drawings.

T7.4 Mechanical and Structural Works

T7.4.1 General

All materials shall be new, the best of their respective kinds and of such as are usual and suitable for work of like character. All materials shall comply with the latest Japanese Industrial Standard (JIS) unless otherwise specified or approved by the PMO/Engineer.

All workmanship shall be of the highest class throughout the Works to ensure smooth and vibration free operation under all possible operating conditions, and the design, dimensions and materials of all parts of the Plant shall be such that the stresses to which they may be subject shall not render them liable to distortion, undue wear, or damage under the most severe conditions encountered in service.

All parts of the Plant shall conform to the dimensions shown on and shall be built in accordance with "FOR WORK DRAWINGS". All joints, datum surfaces, and matching components shall be machined and all castings shall be spot faced for nuts. All machined finishes shall be shown on the drawings. All screws, bolts, studs and nuts and threads for pipes shall conform to the latest standards of the International Organization for Standardization (ISO) covering these components and shall conform to the standards for metric size. The Contractor shall use exclusively the standards and size system accepted and incorporated in the Contract.

T7.4.2 Castings

All castings weighing 226.8 kilograms (500 pounds) or more shall have test coupons attached from which test specimens may be prepared. The number, size and location of the test coupons shall be to the approval of the PMO/Engineer. Faulty material or materials found to be inferior to that specified shall be rejected and removed at once, and shall not be used in any part of the Plant.

All castings shall be dense, sound and true to pattern, of workmanlike finish and of uniform quality and condition, free from blowholes, porosity, hard spots, shrinkage, cracks or other injurious defects, and shall be satisfactorily cleaned for their intended purpose. All castings shall be checked for defects before final machining.

Casting shall not be repaired, plugged, or welded without permission of the PMO/Engineer. Such permission will be given only when the defects are small and do not adversely affect the strength, use or machinability of the castings. Excessive segregation of impurities or alloys at critical points in a casting will be cause for its rejection. The largest fillets compatible with the design shall be incorporated wherever a change in section occurs.

Surfaces which do not undergo machining and are exposed in the final installation shall be dressed to provide a satisfactory appearance so that they will not require surface smoothing at the Site prior to painting.

T7.4.3 Forgings

The ingots from which the forgings are made shall be cast in metal moulds. The workmanship shall be first-class in every respect and the forgings shall be free from all defects affecting their strength and durability, including seams, pipes, flaws, cracks, scales, fins, porosity, hard spots, excessive nonmetallic inclusions and segregations.

The largest fillets compatible with the design shall be incorporated wherever a change in section occurs. All finished surfaces of forgings shall be smooth and free from tool marks.

The forging shall be clearly stamped with the heat number in such location as to be readily observed when the forging is assembled in a complete unit.

T7.4.4 Floor plate

Floor plate shall be of an approved raised pattern. All edges of plate shall be planed and joints shall be cut so as to maintain continuity of pattern.

T7.4.5 Walkways, ladders and handrails

Adequate walkway, ladders, and safety handrails and guards shall be provided on and around each equipment, where necessary, to afford access to and protection from all moving and electrical parts. Such items shall be designed to facilitate easy removal to permit free access to the various parts of the equipment.

T7.4.6 Machine work

(1) General

All tolerances, allowances and gauges for metal fits between plain cylindrical parts shall conform to the appropriate Japanese Industrial Standards or other approved equivalent standards for the class of fit as shown or otherwise required. Sufficient machining stock shall be allowed on locating pads to ensure true surfaces of solid material. Bearing surfaces shall be true and exact to secure full contact. Journal and sliding surfaces shall be polished and all surfaces shall be finished with sufficient smoothness and accuracy to

ensure proper operation when assembled. Parts entering any machine shall be carefully and accurately machined. All drilled holes for bolts shall be accurately located and drilled from templates.

(2) Finished surfaces

Surfaces finished shall be indicated on the Contractor's drawings and shall be in accordance with the appropriate Japanese Industrial Standards or other approved equivalent.

Compliance with specified surface will be determined by sense or feel and by visual inspection of the work compared to standard roughness specimens, in accordance with the provisions of the above stated standards.

(3) Unfinished surfaces

So far as is practicable, all works shall be arranged to obtain proper machining of adjoining unfinished surfaces. When there is a large discrepancy between adjoining unfinished surfaces, they shall be chipped and ground smooth, or machined, to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions shown on the drawings and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts may be filled in an approved manner.

(4) Pins and pin holes

Pin holes shall be bored to gauge, smooth and straight, and at right angles to the axis of the member. The boring shall be done after the member is securely fastened in position. Pins shall be of hardened and ground steel and positively held in position. Wheels or rollers for use in gates shall be mounted on removable pins and have self-lubricating bushings and brass washers.

T7.4.7 Balancing

All revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds and at any load up to the maximum, there shall be no excessive vibration due to lack of such balance and the Plant shall operate with the least possible amount of noise.

T7.4.8 Small bore piping

Seamless steel pipe and/or copper pipe shall be used for all oil lines. Galvanized steel pipe or copper pipe shall be used for all air or gas lines. Steel pipe shall be used for water lines.

All necessary studs, bolts, screws, nuts, washers, gaskets, packing, supports, etc., required in connection with the field assembly of the piping system, shall be supplied by the Contractor. All gaskets and packing shall be of approved material and of a type that has proved satisfactory for the service conditions, to which they will be subject.

Piping shall be installed in the locations, elevations, and to the lines shown on the "FOR WORK DRAWINGS". All lines shall be sloped to allow drainage at the low point. Where a branch cannot be drained through fixtures, a drain valve shall be provided on an accessible location.

All piping shall be fitted and assembled to introduce the minimum of stress to the pipe, fittings and relevant structures, and the assembly shall conform to the best piping practice.

Pipes unions, flexible joints and dismantling flanges shall be fitted where necessary to facilitate installation or maintenance of equipment, as directed and approved by the PMO/Engineer.

The Contractor shall supply and install all pipe hangers, brackets and supports required for support of piping, including drilling and caulking for expansion anchors and any work incidental to the setting of such embedded anchors or inserts in concrete.

Unless other wise specified, pipe supports shall be spaced at 2-meter centers maximum for steel pipes and 1-meter centers for copper tubes. Piping hangers for copper tubes shall be copperplated and of an approved type. Vertical runs shall be supported by means of pipe clamps or collars at each floor. Hangers and supports shall be painted. Pipe supports to be embedded in concrete shall be made of material, which will not deteriorate, weaken or cause damage to the pipe.

T.7.4.9 Joint of structural members

The connections between each structural member shall be by means of bolting or welding and designed in such a manner that all forces are transmitted by one of such method of connection as bolting or 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 of

5 millimeters thick. For all sloping surfaces, beveled 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 machine or other approved methods so as to be suitable for the type of weld employed.

T7.4.10 Embedded steelwork, opening, etc.

The Contractor shall supply and install all anchors, fasteners, embedded steelwork, piping, conduits and sleeves associated with and required for the equipment being provided and installed under this Clause, except as otherwise provided in the Specifications and Drawings.

The Contractor shall show the location and full details of all embedded components on his drawings and shall be responsible for the completeness and accuracy of his drawings.

Any steel work which is to be set into the concrete foundations shall not be painted nor coated unless otherwise approved.

During installation of all embedded steel pipes, the openings of each pipe end shall be plugged by suitable covers which shall be removed after completion.

T7.4.11 Welding

(1) General

All welding shall be done either manually by the shielded metallic arc process or automatically by the shielded arc or submerged arc method. The Contractor shall develop and submit a welding procedure for the approval of the PMO/Engineer. After the welding procedure has been approved, the Contractor shall record it on a special drawing which shall thereupon become one of the drawings of the Contract. Weld sizes and types shall be shown on all Contractor's drawings where welding is employed.

Non-destructive examination such as radiographic or ultrasonic, or magnaflux or dye-penetrated inspection shall be carried out by the Contractor when required by the standards, these Specifications or the design criteria employed. All important welds which, in the opinion of the PMO/Engineer, may be subject to the full stress induced in the adjacent

plate, or which in the opinion of the PMO/Engineer, do not appear to conform to the welding standards, shall be non-destructively tested.

Suitable meters shall be provided to show the welding current and the arc voltage at all times during the welding operations. Unless otherwise specifically stated, welded parts requiring machine finish shall be completely welded before being finished.

All welds shall be usually made continuous and watertight. The minimum throat dimension of fillet welds shall be 4.5 millimeters.

Plates to be jointed by welding shall be accurately cut to size and rolled by pressure to the proper curvature which shall be continuous from the edge. Flattening in the curvature along the edges with correction by blows will not be allowed. The dimensions and shape of the edges to be joined shall be such as to allow thorough fusion and complete penetration and the edges of plates shall be properly formed to accommodate the various welding conditions. The surfaces of the plates for a distance of 25 millimeters from the edge to be welded shall be thoroughly cleaned of all rust, grease and scale, to bright metal.

(2) Qualification of welding procedure

The technique of welding employed, the appearance and quality of the welds made and the methods used in correcting defective work, shall conform to the requirements in American Welding Society (AWS) Standard D.1.1, or other standard, as proposed in the Tender and subsequently incorporated into the Contract.

(3) Qualification of welders and welding operators

All welders and welding operators assigned to the Works shall have passed a qualification test, within the preceding six (6) months, for welders and welding operators, in accordance with JIS Z 3801 and/or Z 3841 or other approved equivalent standard. The Contractor shall furnish the PMO/Engineer with certified copies of reports of the results of physical tests of specimens welded in the qualification tests.

If, in the opinion of the PMO/Engineer, the work of any welder at any time appears questionable, he shall be required to pass the appropriate requalification test. All costs of such requalification tests shall be borne by the Contractor.

(4) Welding electrodes

The welding electrodes shall conform to JIS Z 3211 or Z 3212, low hydrogen type covering or other approved equivalent.

Stainless type weld metal, where used in the water passages for protection against pitting, shall be of chromium nickel steel. The type, chemical composition and JIS number of welding rods for this purpose shall meet with the approval of the PMO/Engineer.

(5) Repair

If the workmanship is not satisfactory to the PMO/Engineer, the welding shall be chipped out to sound metal, tested and repair welded, subject to approval of the PMO/Engineer. The welding work contained such defect shall be inspected and tested all along the line by the same method used first as instructed by the PMO/Engineer to his satisfaction.

T7.4.12 Lubrication

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 so hard, 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.

T7.4.13 Protection, cleaning and painting

(1) General

The painting of the Plant shall include the preparation of the metal surfaces, paint application, protection and drying of the paint coatings, as well as the supplying all tools, labours and materials necessary for the entire painting work.

The finish color of all Plant shall be approved by the PMO/Engineer under the confirmation of the Employer. The Contractor shall propose a color scheme for the equipment and shall submit color chips or paint samples. Color chips shall be included with the approved painting specifications for each type of finish. The color of all undercoats shall match the color of the finish coat.

The paint shall be a product of reputable manufacturer and shall be delivered in the manufacturer's sealed tins, stored under cover and used within the storage time and in accordance with the method recommended by the manufacturer.

The Contractor shall prepare and submit the painting specifications for approval of the PMO/Engineer in the manner as stipulated in Clause T7.2 "Drawings and Documents to be Supplied by the Contractor". The painting specifications shall cover paint schedule, manufacturer's statement of the physical and performance characteristics for paint materials to be selected, and manufacturer's recommended procedures for the surface preparation, application, handling instructions, equipment, ambient conditions, mixing instructions, safety and storage instructions etc. The procedures shall also include any special requirements for field repairs to the damaged coating and for the coating of field joints.

All parts which will ultimately be buried in concrete shall be cleaned and protected, before leaving the manufacturer's shop, by a Portland cement wash or other approved method. Before being installed they shall be thoroughly descaled and cleaned of all rust and adherent matter.

(2) Surface preparation

All oil, paraffin, grease and dirt shall be removed from the surfaces to be painted, by wiping the surfaces with a clean cloth dipped in mineral solvent. Following solvent cleaning, all weld spatter, slag, burrs, loose rust and mill scale and other foreign substances shall be removed by shot or grit-blasting to "Sa 2 1/2" of Svensk Standard SIS 055900 or SSPC-SP10 of Steel Structures Painting Council Manual Volume 2. Special attention shall be given to cleaning of corners and converging angles.

Blast cleaned surfaces showing plate surface defects such as scabs or sharp gouges shall be repaired in an approved manner prior to painting.

After blast cleaning, the surface shall be dusted off or blown off with compressed air free of detrimental oil and water. All surfaces to be painted shall be completed dry, clean and free from moisture just prior to and during painting. If rust forms or the surface become contaminated in the interval between cleaning and painting, recleaning to the same degree shall be required.

(3) Application procedure

The application of protective coating shall be carried out at the Contractor's shop and/or field shop, whenever possible. Painting work at erection site shall be limited to touch-up coatings for damaged areas and coatings for field welding portions.

All paint, when applied, shall provide a satisfactory film and a smooth and even surface. Paint shall be thoroughly stirred, strained, and kept at the uniform consistency during application. Paint shall not be applied when the temperature of the metal or surrounding air is below 10 degrees Celsius and that of the metal is above 50 degrees Celsius, or when the humidity is above 90 per cent, or when it threatens to rain before the painted coat gets dry. Each coat shall be protected during the initial curing period against the possibility of moisture condensation or contamination with foreign matter. All painting works shall be performed by brushing and/or airless spraying.

When the coating material is applied by spraying, suitable means shall be provided to prevent segregation during the coating operation. Free oil and moisture shall be removed from the air supply lines of all spraying equipment. Each coat shall be uniform and free from runs, sags and other imperfections. The time between successive coats shall be not less than the minimum nor more than the maximum recoating time specified by the paint manufacturer.

The paint shall be applied so that the thickness at any point is not less than that stipulated in the approved painting specifications.

Surfaces not required to be coated, but adjacent to surfaces which are to be cleaned and coated, shall be adequately protected during cleaning and coating.

Repairs to damaged areas of the coating shall be carried out strictly in accordance with the approved painting specifications.

Because of the flammable and toxic nature of the coating materials, the Contractor shall take precautions to eliminate any health or safety hazard that may arise during the application of the coating. Smoking and welding shall not be allowed within 10 meters of the place when painting is in progress.

Where steelwork is to be welded, only the primer shall continue over the weld area. Subsequent coats shall be kept back 150 mm from the weld and completed after welding. The primer shall be such that no toxic fumes are given off during welding. Alternatively,

approved temporary protection such as taping may be provided as an alternative to priming the weld areas. The edges of shop coats exposed on removal of the tape shall be treated in accordance with the manufacturer's instructions to ensure adhesion to coats applied at the Site.

Painting shall be stopped off 75 millimeters from the edges of interface areas for high strength friction-grip bolts. Painting over and around such bolts shall be completed as specified after assembly.

(4) Surfaces not to be painted

Bronze, brass, machined parts surfaces of gear teeth, finished ferrous surfaces, surfaces in rolling or sliding contact after field assembly and hoist ropes shall not be painted. All corrosion-resisting steel surfaces for bearings and machinery parts shall also not be painted.

On completion of cleaning, the surfaces not to be painted shall be coated with an approved rust preventive coating material or an adhesive plastic film to protect the surfaces from minor mechanical damage and corrosion during shipment and storage at the Site. The coating material shall be stripped off after field erection of equipment.

Unassembled fittings, pins, bolts and nuts shall be oiled and wrapped with moisture-resistant paper or protected by other approved means.

(5) Paint schedule

One epoxy resin zinc rich primer coat and two or three coats of coal-tar epoxy resin paint, total dry film thickness of 0.45 - 0.60 millimeter, shall be applied to the following items:

Alll gate leaves,
All trash racks,
Internal surface of steel conduits,
Internal surface of valves,
All guide frames

One epoxy resin zinc rich primer coat, two coats of non-bleed type tar epoxy resin paint as under coats, one coat of epoxy resin micaceous iron oxide paint as an intermediate coat and two coats of chlorinated rubber paint as finish coats, total dry film thickness of 0.45-0.60 millimeter, shall be applied to the following items:

Exposed surface of valves,

Exposed surface of pipes and conduits,
Exposed surface of hoisting equipment

All unfinished surfaces of ferrous metal except those above specified shall be so given one zinc rich primer coat and four coats of chlorinated rubber paint (two under coats, one intermediate coat and one finish coat) as to have the total dry film thickness of 0.15 - 0.18 millimeter.

Commercial equipment other than those specified above may be painted in accordance with the manufacturer's standard practice, subject to approval of the PMO/Engineer.

(6) Inspection

All painting works shall be inspected by the Contractor himself in accordance with the approved test procedure prescribed in sub-clause T7.3.3 "Test procedure instructions", subject to approval of the PMO/Engineer.

Following to the visual inspection on surfaces that have been coated, the dry film thickness of coating shall be checked at as many spots of the coated area as possible to prove the thickness overall to be to the specified minimum thickness by the electro- magnetic thickness meter. Further, for the purpose of measuring the continuity of coatings, coated areas shall be examined by the pin hole detector ("Holiday" detector).

T7.4.14 Mechanical equipment and parts

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

(1) Gearing

All gears shall be machine cut, preferably by hobbing, from solid blanks and, wherever possible, they shall be a forced fit on their shafts. The minimum requirements for materials are as follows:

Wheels	Rolled or forged steel
Pinions	Rolled or forged steel
Worm Wheels	Steel with bronze rims
Worms	Steel or forged steel

Where worm gearing is used as a first motion drive, it shall be designed to have the same load and time rating as the driving motor and to have oil tight removable housings with lubrication oil plug, drain cock and oil level indicator. The temperature rise of the oil bath, when measured by thermometer, shall not exceed 40 degrees Celsius.

All gear wheels and pinions shall be completely covered by steel or other metal guards, unless effectively guarded by adjacent structures.

Keys in gear trains shall be so fitted and secured that they cannot work loose.

(2) Couplings

Flexible gear type couplings with means for field adjustment shall be provided where drive shafts are required to be connected.

(3) 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.

(4) 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.

(5) Dowels

Gear boxes and bearings which have to align accurately shall be retained in position by means of fitted dowels during assembly.

(6) Manual operating devices

The operation force on the manual operating device shall be less than 10 kilogram force under normal design condition.

The diameter of the handle shall be 700 millimeters in maximum which shall be located at approximately 1.00 meter in height from the operation deck.

(7) Structural base frames of hoist

The structural base frame of hoist shall be of all welded steel construction using rolled structural shapes and plates. Necessary anchor bolts and nuts for the base frames shall be supplied by the Contractor.

(8) Torque shafts

The torque shafts shall be finished commercial steel shafting. The diameter of the shafts shall not be less than 50 millimeters.

(9) Screwed spindles

The screwed spindles shall be made of corrosion resisting steel which shall be machine-cut with trapezoidal thread at the necessary length. Lock nuts shall be provided to limit the upper and lower traveling of gate leaf.

(10) Spindle supports

The spindle supports for each hoist mechanism shall be provided at proper position(s) to avoid the buckling of spindle due to over-lowering force when the gate is jammed or closed.

The support shall be removable to permit drawing out the gate from hoist deck opening. Corrosion resisting steel bolts, nuts and washers shall be used for fixture of the support.

(11) Mechanical position indicators

The mechanical type position indicators, except where otherwise noted, shall be mounted on each hoist mechanism, and shall be of an easily readable dial type to rotate about 300 degrees for full travel. The dial plate shall be of stainless steel or brass with engraved graduation, and main parts of the indicators shall be made of anti-corrosive materials which shall be housed in a dust-tight and weather-proof enclosure. The indicators shall be capable of reading accurate vertical height of the equipment opening by 1.0 centimeter.

T7.5 Electrical Equipment and Parts

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

T7.5.1 Motors

All motors shall be of horizontal shaft, high starting torque, low starting current, squirrel cage, induction type, designed for full voltage starting, weather-proof and totally enclosed. Wound rotor motors will be accepted only if a squirrel cage type would not be satisfactory for the duty.

The insulation for the motor shall be decided by the capacity in accordance with JIS C 4210 or other approved equivalent standard, and continuous rating at 40 degrees Celsius ambient temperature. The cable terminal boxes shall be provided preferably with stud-type connectors.

The capacity of motor shall be examined with the following equation, and the rated motor capacity shall be more than 100 per cent of that calculated based on the maximum hoisting loads, which will occur during starting, raising and lowering operation of the gate or equipment. The starting and maximum torque of the motor shall be more than 200 per cent, but less than 300 per cent of its rated torque respectively.

$$Qp = \frac{W \times V}{6.12 \times n}$$

where,

Qp : Output of motor (kW)

W : Maximum hoisting load (tons), selected under the most adverse combination of loads which shall be calculated with the given friction coefficients and operating conditions

V : Hoisting speed (m/min.)

n : Total efficiency of mechanical parts

Windings and connections shall be suitably impregnated to render them moisture-proof, nonhygroscopic and unaffected by conducting dust.

All motor bearings shall be of the ball or roller type with an inner grease seal to prevent grease from entering the winding. Bearing housings shall be fitted with a "ball in head" grease fitting and a removable plug for the escape of grease.

T7.5.2 Motor brakes

The brakes mounted on hoisting motors shall be of spring applied and A.C. solenoid released type. The rated capacity shall not be less than 150 per cent of the rated full load torque of the motor. The brake shall be arranged for automatic application, when the motor power supply is cut off, and release when the motor is energized. The brake enclosure shall be weather-proof with convenient access for maintenance.

T7.5.3 External electric cables and wiring

The Contractor shall be responsible for wiring, laying and furnishing of control and power cables and/or wires which are necessary for the required operation of the Plant covered under this Chapter.

There shall be no splices in the wires or cables and all connections shall be made only at terminal blocks or studs.

All external wiring between the distribution panel, control cubicles, motors, limit switches etc., shall be with multicore copper, cross-linked polyethylene insulated, PVC sheathed (Type CV), 600-volt grade cable.

All external wiring excluding overhead lines shall be laid down into protective steel conduits. The Contractor shall supply and install all conduits and materials necessary for the wiring.

All main power circuit conductor shall be of copper and have a minimum cross-sectional area of 60 square millimeters.

All power and control cable conductors shall be of copper and have a minimum cross-sectional area of 2.0 square millimeters unless otherwise specifically specified in these Specifications. Single strand conductor shall not be accepted.

Compression type terminal shall be used and ring number identification shall be put at both ends of the cables.

T7.5.4 Equipment wiring and wiring accessories

This sub-clause applies to all connections within equipment enclosures and all inter-cabinet wiring working at voltages not greater than 380 V nominal. All wiring shall be carried out in accordance with approved wiring diagrams so that the arrangement of the wiring is consistent throughout the equipment and identical for those parts of the equipment performing the same duties.

Wiring diagrams shall be drawn viewing from the back (i.e., wiring side) of the cabinet (except for front connected equipment) and shall show all terminals of selector switches, relays, contractors, terminal blocks etc. in their correct relative positions.

Wiring shall be neatly and securely bunched or cleated, and enclosed in ducts, or conduits or supported on trays and run in the most efficient manner from point to point. The bunching of wiring shall be kept in bunched condition by means of strips of special plastic ribbon material at suitable intervals. Lacing or wire bunches with textile or plastic cord or metal buckle type clips will not be accepted. Wherever wiring is cleated to metal surfaces, it shall be insulated from the metal surface and shall be cleated by means of insulated straps in an approved manner. All wiring shall be left sufficiently long and neatly looped to allow a fresh termination to be made in case of original termination device being broken off.

Circuits of similar nature shall be grouped together and terminal block terminals in A.C. circuits shall be segregated and fully shrouded to prevent accidental contact with live parts.

All secondary wiring shall employ conductors having a minimum cross-section of 2.0 square millimeters and consisting of tinned copper wire. Internal wiring of miniaturized and solid state equipment may use flexible conductors having a minimum size of 50/0.18 millimeter where wiring is made off to clamping type terminals and 30/0.18 millimeter where the termination is made by soldering.

Current transformer secondary circuits shall be run with the conductor route length as short as possible. The burden of the leads associated with current transformers and protective relays shall be sufficiently low to ensure correct operation of the protection under all conditions and this may require a cross-section of conductor greater than 2.0 square millimeters.

Insulation shall be PVC of 250 V or higher grade appropriate to the service conditions and shall be self-colored in accordance with a code which is the same for all of the equipment. The Contractor shall submit the color code to the PMO/Engineer for approval and shall make such changes in the code as are required to achieve consistency with the Employer's standards.

T7.5.5 Motor starters

All starters shall be suitable for direct-on-line starting of motors, provided with 3-phase overload relays with manual resetting, open-phase relays and reverse-phase release feature. Overcurrent relays shall be field adjustable to correspond with the rated full load currents of the motors. Backup protection shall be provided with high rupturing capacity moulded case circuit breakers with operating handles lockable in "off" position. The control voltage shall be 230-volt, A.C.

T7.5.6 Control cabinet and panel

Control cabinet and panel shall be of sheet steel with minimum thickness of 2.3 millimeters, of rigid, self-supporting construction and supplied with channel bases.

All indicators such as meters and lights shall be visible from outside without opening the doors and/or windows which shall have integral lock and master key. Cabinets and panels shall be of weather, dust and vermin-proof construction, completely enclosed.

The cables and wirings shall enter from bottom side of cabinets and panels. Removable gland plates shall be supplied and located to provide adequate working clearance for the termination of cables. Under no circumstances the floor/roof plate shall be used as a gland plate.

Space heating elements with thermostatic control shall be included in each cabinet/panel.

The instrument and control wiring including all electrical interlocks and interconnecting wiring between sections, shall be completely installed and connected to terminal blocks by the Contractor.

The arrangement of control and protection devices on the cabinets/panels and the exterior finish of the panels shall be subject to the approval of the PMO/Engineer.

T7.5.7 Power distribution panel

Power distribution panel shall be of sheet steel with minimum thickness of 2.3 millimeters, of rigid, self-supporting or wall mounted construction.

The panel shall be of weather, dust and vermin-proof construction, completely enclosed.

The cables and wiring shall enter from bottom side of the panel.

The source pilot lights shall be provided and visible from outside without opening the doors and/or windows which shall have integral lock and master key.

T7.5.8 Conduits

Rigid steel conduit shall be galvanized inside and outside. It shall be of a minimum thickness of 2.3 millimeters and have a minimum inside diameter of 16 millimeters.

T7.5.9 Enclosures

Motor enclosures shall be weatherproof and totally enclosed. Enclosures for all other equipment shall dustproof, weatherproof and verminproof.

T7.5.10 Convenience outlets

Convenience outlets shall be of 2-pin with scraping earth or 3-pin type rated for 15 amps at 230 volts, suitable for British pattern plug. Outlets shall be in weatherproof enclosure or suitably protected from weather.

T7.5.11 Limit switches

The limit switches shall have weatherproof enclosures and shall be mounted suitable for easy adjustment and protection from vandalism, and for rigidly locking in position after being adjusted. They shall be of heavy-duty rating and shall have corrosion-resisting steel rotating parts and permanently lubricated bearings. They shall allow the arm to be fully deflected by the operator without damage to the switch.

T7.5.12 Indicating lights

All indicating lights shall be of filament with colored plastic lenses type for long life and service under conditions of shock, vibration and rough handling. All indicating lights on outdoor cubicles shall be visible under daylight.

T7.5.13 Lighting fixtures

Fluorescent lighting fixtures shall be equipped with complete fittings for A.C. 230 volt, 50 Hz sources and a ballast or ballasts of high power factor.

Incandescent lighting fixtures shall have lamp holders in accordance with the local standards.

Special care shall be exercised on selection of fixtures so that illumination of the lamp is not obstructed by accumulation of insects and dust.

T7.5.14 Electrical relays

Electrical relays for controls and alarm purposes and auxiliary relays for protection circuits shall be of the plug-in type and the plug-in connections shall be made and broken by pressure contacts. Alternatively, the PMO/Engineer may approve the use of plug-in trays containing groups of relays.

Relays shall be provided with non-flammable dust and moisture-proof cases.

Relay contacts shall be adequately rated for the service conditions. Relay coils shall be continuously rated whether the control scheme requires them to be continuously energized or not.

At least one spare normally open contact and one spare normally closed contact shall be provided on each relay in addition to the contacts required by the control scheme.

T7.5.15 Terminal strips

Terminal strips shall be of double stud and 2-hole solid link design with the studs moulded into an insulating base. Pinch-type terminal blocks and slotted links are not acceptable. Studs shall be of brass and 6 millimeters diameter except that studs of 4.7 millimeters diameter in corrosion-resisting steel or phosphor-bronze may be approved.

Terminal strips shall be arranged in vertical rows not less than 225 millimeters above floor level. Sufficient terminals shall be provided on each item of equipment to permit the connection of all incoming cable cores plus 10 per cent spare terminals.

Removable transparent insulating covers shall be provided over all terminals. An insulating barrier shall be provided between adjacent pairs of studs.

T7.5.16 Indicating instruments

All instruments and meters shall have approximately 110 millimeters dial and shall be heavy-duty, dust-proof, industrial type suitable for extreme shock and severe vibration applications.

Instruments on cabinets shall be flush mounted and provided with narrow bezels. The bezels shall have a uniform high grade finish.

All instrument scales shall be of wide angle type clearly printed in black figures and divisions on white background. The figures and units shall be clearly marked on the instrument dial in black capital letters. The names or marks of the instrument's manufacturer and other printing which may interfere with the clear observation of the reading shall not be printed on dials. Initials or similar markings may however be acceptable in case they are indicated unobtrusively on dial plates, subject to approval of the PMO/Engineer.

Unless otherwise specified or approved, all instruments shall have circular scales with a total deflection of not less than 240 degrees.

Normal working indication shall be at a point corresponding to approximately 75 per cent of full scale deflection. Scales shall be provided with red-colored marks at points corresponding to the normal working values (or full-load current of the equipment in case of ammeters) and as approved.

The scales for ammeters in motor circuits shall be suppressed so that 20 per cent of full scale deflection (F.S.D.) occurs at about 40 per cent full load current (F.L.C.) and 90 per cent of F.S.D. at about 120 per cent F.L.C. The scale shall be approximately linear in the range 40 per cent to 120 per cent and compressed above 90 per cent F.S.D. to indicate 6 times F.L.C. at 100 per cent F.S.D.

Devices for routine checking, zero adjustment and re-calibration shall be easily accessible from the front of the cabinets. Where such devices are not included in the instrument case they shall be flush

mounted on the cabinets adjacent to the associated instruments, so that adjustments can be made conveniently while watching the indicator.

T7.6 Packing, Delivery and Storage

T7.6.1 Packing

Each item shall be packed properly or protected for shipment from the place of manufacturer's shop to the Site.

Each crate of package shall contain a packing list in a waterproof envelope and a copy in triplicate shall be forwarded to the PMO/Engineer prior to delivery. All items of material shall be clearly marked for easy identification against the packing list.

All cases, packages etc., shall be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and the correct position of the slings and shall bear an identification mark relating them to the appropriate shipping documents.

Cases which cannot be marked as above shall have metal tags with the necessary marking on them. The metal tags shall be securely attached to the package with strong steel wire or equivalent.

The PMO/Engineer shall reserve the right to inspect the packing before delivery to the Site. The Contractor shall be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not relieve the Contractor from responsibility for any loss or damage due to faulty packing.

All packing materials shall remain the property of the Contractor and shall be removed from the Site at the earliest opportunity and be disposed at the places/areas which will be instructed by the PMO/Engineer.

The shipping mark shall consist of the following information in sequence and in frame commensurate with the size of container:

(a) Consignee : _____

(b) Contract No. : _____

(c) Port of destination : _____

(d) Item Number, if applicable, package number in sequence, and quantity per package : _____

(e) Description of contents : _____

(f) Net and gross weight, cubic measurement : _____

T7.6.2 Delivery

The Contractor shall deliver all Plant including Contractor's Equipment provided under this Chapter to the Site in adequate time for its preparation and erection according to the construction time schedule.

No part of the Plant and Contractor's Equipment shall be delivered to the Site until approval in writing has been obtained from the PMO/Engineer for such delivery.

Notification of such delivery shall be given to the Employer and to the PMO/Engineer in writing not later than fourteen (14) days prior to the actual shipping date for any equipment to be shipped. Each notification shall include a complete shipping list of the contents of each package to be delivered and shall indicate the expected date of delivery and the serial number for each component to be used for identification and copies of the insurance policy arranged for it.

The Contractor shall be responsible for the reception at the Site of all deliveries for the purpose of the Contract.

The Contractor shall at his responsibility inspect the cargoes at the Site upon arrival of the cargoes and shall report in writing the particulars, quantities, conditions, damages, if any, of the cargoes to the Employer and to the PMO/Engineer within three (3) days after arrival.

T7.6.3 Storage at site

The Contractor shall be responsible for all routine maintenance, i.e., lubricating, inspection and adjusting of all equipment of the Plant, until the issuance of the Taking-over Certificate.

The Contractor shall arrange at his own expense for covered storage or other protection of all materials and equipment against corrosion and mechanical damage. Any corrosion or damage that may occur to any item of the Plant shall be made good before that item is to be installed.

The Contractor shall provide all drainage and weather protection for storage of the Plant to meet the requirements of the PMO/Engineer.

The minimum requirement is that all items shall rest on wooden blocks which elevates the base at least 150 millimeters above floor or ground level. No items shall rest on the floor or ground directly.

All cases containing important machinery and electrical parts shall be stored in the warehouse which shall be provided by the Contractor.

Weatherproof items and structural steel members may be stored in the open, but in all instances shall be protected to the PMO/Engineer's approval. The Contractor shall be responsible for the adequacy of all protection.

T7.7 Tests and Inspection

T7.7.1 General

During the manufacturing, the construction and after the installation work of each item of the Plant in this Chapter, the Contractor shall perform the tests as described in the test procedures to establish the accuracy of assembly and to prove the adequacy of the materials and workmanship.

The Contractor shall give the PMO/Engineer written notice of the data of the tests not less than 21 days in advance.

The Contractor shall provide all man power, tools, meters, materials etc. necessary to conduct the tests and shall be fully responsible for the tests.

Any defect observed during the tests shall be repaired and improved by the Contractor and be tested until it fulfills the Specifications. No part of the Plant shall be considered acceptable until it has successfully complied with the Specifications.

T7.7.2 Material inspection and test

Materials, parts and assemblies thereof, entering into the Plant shall be tested, unless otherwise directed, according to the best commercial method for the particular type and class of work. When the manufacturer desires to use stock material not manufactured specifically for the equipment furnished, satisfactory evidence that such material conforms to the requirements herein stated, shall be furnished, in which case tests on these materials may be waived. Certified mill test reports of plates and sections will be acceptable.

Witness tests and inspection of material may be made at the place of manufacture by the PMO/Engineer, unless otherwise specified. Such witnessing and inspecting will be conducted so as to interfere as little as possible with manufacturing operation. The Contractor shall however comply with any reasonable request made by the PMO/Engineer concerning the method of test or correction of defective workmanship.

The Contractor shall furnish, free of charge, all test pieces, blankets etc., cut and machine to the sizes, shapes and dimensions as directed by the PMO/Engineer. The testing of the specimens shall be carried out by the Contractor at his own cost and expense, and shall be performed in accordance with the approved test procedure instructions.

Test pieces which represents rejected material shall be preserved and become the property of the Employer.

Waiving of inspection by the PMO/Engineer shall not exonerate the Contractor from any of his responsibility for supplying material and workmanship acceptable to the PMO/Engineer.

T7.7.3 Tests at manufacturer's shop

All items of equipment shall be assembled in the shop prior to shipment and tests shall be performed by the Contractor as may be required to demonstrate to the satisfaction of the PMO/Engineer the adequacy of the equipment and its component parts. All tests should be simulated to normal operating conditions as closely as possible. All dismantled parts shall be properly matchmarked and dowelled to ensure correct assembly at the Site.

Tests at manufacturer's shop shall be performed in accordance with the requirements of the appropriate paragraph of the equipment in this Chapter and approved test procedure instructions.

The Contractor shall provide the PMO/Engineer with five (5) copies of all inspection and test reports per every shipment/delivery, together with the written application for issuance of the "Certificate of Inspection" as required in Clause T7.10 "Measurement and Payment" within thirty (30) days after completion of such inspection and test.

As soon as the inspection and test as specified in the Contract have been satisfactorily completed and the corresponding reports have been accepted by the PMO/Engineer in accordance with the above requirements, the PMO/Engineer will issue a "certificate of Inspection" per every shipment/delivery in which he shall certify the date on which the said inspection and test have been completed and the particulars of the Plant inspected and tested. Issuance of such Certificate of Inspection shall not release the Contractor from any of his obligations under the Contract.

T7.7.4 Tests at site

The Contractor shall take out the equipment from their packings and shall inspect the equipment for damage as prescribed in sub-clause T7.6.2 "Delivery". The Contractor shall repair or replace any damaged portion of the equipment, subject to approval of the PMO/Engineer.

During the construction and after the installation of each item of equipment, control device, piping system etc., tests shall be performed, as specified in this Chapter, to establish the accuracy of the assembly and to prove the adequacy of the equipment and the workmanship. All tests shall be made upon approval of the PMO/Engineer.

T7.7.5 Tests on completion

After any section or the whole of Plant under this Chapter has been fully installed, adjusted, tested and approved and parts under other chapters for operating the Plant are fully installed, the Contractor shall conduct the Tests on Completion in the presence of the Employer and the PMO/Engineer to demonstrate that the Plant has been correctly installed, all necessary adjustment and setting made, and is free from vibration and leakage under load, and meets the Specification in all respects.

T7.7.6 Test and inspection reports

Unless otherwise specified, the Contractor shall submit to the PMO/Engineer all tests and inspection reports in accordance with following manner:

Place of test or inspection	Number of report	Submitting time
Manufacturer's shop	6	Before application for shipment
Site after the test	6	Within 14 days

T7.8 Spare Parts

The Contractor shall furnish the spare parts as listed in the Appendices and to Bill of Quantities.

Any spare part supplied shall be packed or treated in such a manner as to be suitably stored in the climate at the Site for a period of not less than five (5) years, and each part shall be clearly marked with its description and purpose on the outside of the packing.

Spare parts so provided shall be delivered into such stores as may be designated by the Employer and delivery will not be deemed to be complete until the packages have been opened by the Contractor, their contents checked by a representative of the Employer and the articles reprotected and repacked by the Contractor to the satisfaction of the Employer, or assembled into units at the Employer's option.

T7.9 Maintenance Equipment and Tools

The Contractor shall furnish one lot of maintenance equipment and tools sufficient for the proper maintenance of all the Plant provided under this Chapter as listed in the Bill of Quantities. The maintenance equipment and tools shall include, but shall not be confined to:

(a) One (1) lot of tools for general use such as wrench sets, iron level, cutting pliers, screw drivers, wire brushes, hammers, vices, jacks, files, saws and oil and grease guns.

(b) One (1) lot of cargo work tools such as lever blocks, chain blocks, snatch blocks and wire ropes.

(c) One (1) lot of measuring instruments such as digital type electro- magnetic paint thickness meter, calipers, steel rule, thickness gauge and stop watch.

(d) One (1) lot of testers such as insulation tester, universal tester.

(e) Any other recommendable equipment and tools.

The maintenance equipment and tools shall be delivered with the Plant, in lockable cabinet(s) fitted internally so that the tools may be safely stored in an orderly manner.

T7.10 Measurement and Payment

The measurement of payment for the Works covered in this Clause shall be made in progress per centage for the Works completed and accepted in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

The payment shall be made on the progress per centage on the basis of lump sum price for the respective items shown in the Bill of Quantities, which prices shall constitute full compensation for the costs of all labour, tools, equipment and materials including designing, manufacturing, transporting, installing, painting, adjusting, testing and all incidentals and subsidiary works necessary for the successful completion, and no separate payment shall be made for such works.

Payment of foreign and local currency portions shall be made in accordance with the following procedures :

(a) Cost for Equipment

(i) Seventy (70) per cent of lump sum price will be paid upon arrival of equipment to the site subject to submission of the following documents:

- Contractor's detailed invoice showing commodity description, quantity, unit price, total price and basis of delivery.

- Certificate(s) of Inspection (Certificate of Quality) issued by the PMO/Engineer,

- Insurance policy or certificate issuced by the manufactuer, and

- Other documents required by the PMO/Engineer, if any.

(ii) Thirty (30) per cent of lump sum price will be paid upon substantial completion of installation approved by the PMO/Engineer.

(b) Cost for instructions to project staff

One hundred (100) per cent of cost for Instructions to Project Staff will be paid upon substantial completion of the instructions approved by the PMO/Engineer.

(c) Cost for maintenance equipment and tools

One hundred (100) per cent of the cost for maintenance equipment and tools will be paid upon arrival of all equipment and tools to the site and approved by the PMO/Engineer under the same conditions mentioned in (a) above.

T7.11 Loads to be Considered

T7.11.1 General

Loads to be considered for the design of the Plant shall be specified in this section.

The Plant shall be designed with the worst possible combination of the loads under the specified loading conditions herein.

T7.11.2 Gate leaf, valves and trash rack

The gate leaf, valves and trash rack shall be designed with the suitable combination of the following loads:

(a) Hydrostatic load

Hydrostatic load shall be of the water head difference between upstream and downstream sides of the gate, valve and trash rack.

(b) Self weight

Reaction due to self weight.

(c) Sediment load

The sediment load for the vertical force shall be taken as the weight of sedimentary silt in water and horizontal force shall be determined by the following formula:

$Pe = Ce\ W1\ d$

where,

Pe : Horizontal force of sediment load at a given point on the contact face (tf/m^3)

Ce : Sediment load factor: 0.6

W1 : Unit weight of sedimentary silt in water: 1.0 tf/m^3

d : Depth from deposit level of sediment given point on contact face (m)

(d) Operating load of hoist

(e) Wind load

The basic wind load of 150 kilogram force per square meter for a vertical projected area shall be applied by the type of structures to be designed upon multiplying by the following corresponding factors:

For plane surface	:	1.2
For a cylindrical surface	:	0.7
For lattice member, at front side	:	1.6
For lattice member, at rear side	:	1.2

(f) Water pressure variation and vibration force induced by flowing water

Water pressure variation and vibration force induced by flowing water shall be considered.

(g) Inertia force during earthquake

Inertia force during earthquake shall be of multiplication value the dead weight by the seismic intensity of 0.05.

(h) All loads imposed by the hoist in gate jammed condition during raising operation.

T7.11.3 Hoist

The hoist shall be designed with the operating load, which shall be the most adverse combination of the following loads in any water level up to design water level:

(a) Dead weight of the gate leaf,

(b) Friction force due to rotating parts and/or sliding parts,

(c) Friction force due to seal rubbers,

(d) Friction force between sedimentary silt and skin plate,

(e) Buoyancy,

(f) Uplift force and down pull force, and

(g) The load resulting from the breakdown or locked-rotor torque of the hoist motor, whichever is greater.

T7.11.4 Other equipment

(a)	Foot path floor, step of staircase, grating	:	Crowded load 500 kgf/m^2
(b)	Step of ladder	:	Vertical load 80 kgf/m^2

T7.12 Materials

All materials of the Plant covered in this CHAPTER shall be new and of high quality, selected particularly to meet the duties required for the proper operation of the Plant, and indicated fully in the Contractor's detailed drawings for approval.

The materials shall meet with the requirements in the latest Japanese Industrial Standards (JIS) listed herein or equivalent and/or better in quality or as approved in advance by the PMO/Engineer unless otherwise specified.

T7.12.1 Steel plates, bars, pipes, etc.

(a)	Steel plates for skin plate, structural main parts, except for rolled steel shape of gate leaves	JIS G 3106, SM41 B and/or SM50 B
(b)	Steel plates for general structures	JIS G 3101, SS41
(c)	Rolled steel shapes	JIS G 3192 and JIS G 3101 SS41 JIS G 3106 SM41, SM50

(d)	Steel bolts, nuts and washers	JIS B 1180, B 1181 and B 1256
(e)	High-strength steel hexagon bolts, hexagon nuts and plain washers for friction grip joint	JIS B 1186
(f)	Spring lock washers	JIS B 1251
(g)	Corrosion-resisting steel plates and bars etc.	JIS G 4303, G 4304, G 4305, G 4306 and G 4307
(h)	Corrosion-resisting clad steel plates	JIS G 3601

T7.12.2 Castings

(a)	Iron castings	JIS G 5501, FC25
(b)	Steel castings (to be fully annealed)	JIS G 5101, SC42
(c)	High tensile strength carbon steel castings and low alloy steel castings	JIS G 5111, SCMnCr 3 B
(d)	Bronze castings	JIS H 5111, BC6
(e)	Phosphor bronze castings	JIS H 5113, PBC2

T7.12.3 Forgings

Carbon steel forgings	JIS G 3201, SF40

T7.12.4 Rubber seals for gate

Seals shall be designed and mounted in such a manner that they are adjustable, water tight and shall be readily removed and replaced.

Seals shall be moulded. Extruded seals will not be permitted. Where seals are installed curved, they shall be clamped in a jig which will form them to the proper radius before the holes are laid out and drilled, and the ends trimmed. Holes in related parts of the seal assemblies shall be carefully drilled, using a template, to assure proper matching when the seal units are assembled. The seals shall be spliced at the corners to provide effective continuity of sealing of the gates. The tensile strength of all splices shall not be less than 50 per cent of tensile strength of the unspliced material.

All adjusting screws, bolts and washers for securing the seals and seal assembly in place shall be of corrosion resisting steel.

Seals shall be made of natural or synthetic rubber suitable for the temperature ranges and conditions at the Site and shall be of a material that has proven successful in similar applications. Seal materials shall have the following physical properties as determined by tests made in accordance with the relevant standards:

Property	Limits
Tensile strength	210 kgf/cm^2 minimum
Ultimate elongation	450 per cent minimum
Durometer hardness (Shore, Type A)	60 to 70
Specific gravity	1.1 to 1.3
Water absorption (70 C° for 48 hours)	5 per cent maximum by weight
Compression set (as a per cent of total original deflection)	30 per cent maximum
Tensile strength after oxygen bomb aging (70 C° for 48 hours) of tensile before aging	80 per cent

T7.12.5 Miscellaneous materials

(a)	Self-lubricating bearing incorporated with high strength brass casting, the solid lubricant	JIS H 5102, HBsC4 (Min.HB 210)
(b)	Steel conduit for oil, air and water piping	JIS G 3452
(c)	Steel conduit for electric wiring	JIS C 8305

T7.13 Design Conditions

T7.13.1 Structural steel members for gate and valve leaves, trash racks and other steel structures

The working stresses for on structural steel members with a thickness of 40 millimeters or less shall not exceed the allowable design stress as shown in the following table under normal loading condition:

(t : thickness)

	Steel material	SS41 and SM41B t < 40 mm	SM50B t < 40 mm
1.	Axial tensile stress (per net sectional area)	1,200 kgf/cm^2	1,600 kgf/cm^2
2.	Axial compressive stress (per gross sectional area)	On condition of (l/r) =< 20, 1,200 kgf/cm^2	On condition of (l/r) =< 15, 1,600 kgf/cm^2
	Compressive members	On condition of 20<(l/r) =< 93, 1,200-7.5{(l/r)-20} kgf/cm^2	On condition of 15<(l/r) =< 80, 1,600-11.2{(l/r)-15} kgf/cm^2
		On condition of 93<(l/r), 10,000,000 kgf/cm^2 6,700+(l/r)^2	On condition of 80<(l/r), 10,000,000 kgf/cm^2 5,000+(l/r)^2
		where, l : buckling length of member (cm) r : radius of gyration of sectional area of member (cm)	
	Compressive splice member	1,200 kgf/cm^2	1,600 kgf/cm^2
3.	Bending tensile stress (per net sectional area)	1,200 kgf/cm^2	1,600 kgf/cm^2
	Bending compressive stress (per gross sectional area)	On condition of (l/b) =< (9/K) 1,200 kgf/cm2 On condition of (9/K)<(l/b)=< 30, 1,200-11{(Kl/b)-9} kgf/cm2	On condition of (l/b) =< (8/K) 1,600 kgf/cm2 On condition of (8/K)<(l/b)=< 30, 1,600-16{(Kl/b)-8} kgf/cm2

b: width of compressive flange (cm)

$K = \sqrt{3 + Aw / 2Ac}$

where,

Aw : sectional area of web plate (cm^2)

Ac : sectional area of compressive flange (cm^2)

In case of (Aw/Ac) <2, K is taken as 2, On condition that compressive flange is directly welded to skin plate, etc.		1,200 kgf/cm^2	1,600 kgf/cm^2
4.	Shearing stress (per gross sectional area)	700 kgf/cm^2	900 kgf/cm^2

Notes :

1) In case the thickness exceeds 40 mm, the allowable stresses for normal loading condition of the structural steel members shall be adjusted as follows:

   The stress shall be 0.92 time that of the allowable stress as mentioned above in case of steel material SS41 and SM41B, and 0.94 time for steel material SM50B.

2) SS41 (JIS G 3101), SM41B and SM50B (JIS G 3106)

T7.13.2 Bar element of trash rack

The stress in the bar elements of trash rack shall not exceed the following critical stress under normal loading condition:

$fcr = 0.6\ fy\ (1.23 - 0.0153L/t)$

where,

fcr : Critical allowable stress (kgf/cm^2)

fy : Yield stress of the material (kgf/cm^2)

L : Laterally unsupported length of bar elements (cm), but $L \leq 70t$

t : Thickness of the bar elements (cm), decreased a corrosion allowance as specified

T7.13.3 Machine parts

The allowable design stresses of all mechanical parts of the equipment shall be examined with the following factors of safety (FS) against the ultimate strength of the steel material defined in Clause T7.12, for normal loading condition:

(Unit: kgf/cm^2)

Material	FS for tensile stress	FS for compressive stress	FS for shearing stress
Rolled steel for general or welded structure	5	5	8.7
Carbon steel forgings or	5	5	8.7
Carbon steel for machine structure use	5	5	8.7
Corrosion-resisting steel	5	5	8.7
Carbon steel castings	5	5	8.7
Gray iron casting	10	3.5	10
Bronze castings	8	8	10

Note: Unit stress shall in no case exceed ninety (90) per cent of the yield stress of the material used under the loading resulting from the breakdown or locked-rotor torque of the hoist motor, whichever is greater.

T7.13.4 Concrete stress

The allowable concrete bearing and shearing stresses shall not exceed 50 and 7 kilogram force per square centimeter respectively.

T7.13.5 Combined allowable stress and overloading condition

The allowable stresses in case of overloading condition and/or the combined stresses resulting from combination of biaxial or triaxial principal stresses may be increased by 50 per cent than those for

normal loading condition. In no case, however, shall any stresses exceed 90 per cent of the yield point strength and/or minimum elastic limit of the steel material used.

The combined stress shall be calculated by the following formula as developed by Mises, Hencky and Huber:

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

where,

fg : Combined stress (kgf/cm^2)

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

fy : Direct stress acting perpendicular to axis of fx (tension is considered as positive) (kgf/cm^2)

fq : Shearing stress (kgf/cm^2)

T7.13.6 Minimum thickness

The minimum thickness of the major structural members shall be 6.0 millimeters and those for the following parts unless otherwise specifically specified herein.

Parts	Min. thickness (mm)
Shell plate for conduit of 1,500 mm	10.0
Skin plates of intake gates	16.0
Bar element of trash rack	12.0
Corrosion-resisting steel plate for:	
Sealing plates	6.0
Sealing plates on sill beams	9.0
Track and bearing plates	9.0
Others	6.0

T7.13.7 Critical slenderness ratio

The critical slenderness ratio for major compression members shall be less than 120, and 150 for secondary members. The said ratio in case of tension members shall be read as 200 and 240 respectively.

T7.13.8 Maximum deflection

The maximum deflection of all gates and shall be less than 1/800 of their supporting spans under the design condition.

T7.13.9 Corrosion allowance

The corrosion allowance for the equipment and structures shall be as follows:

Equipment/structure	Corrosion allowance (mm)
Skin plate of intake gates	2.0
Shell plate of steel conduits	2.0
Screen bars for trash racks	2.0

T7.13.10 Coefficient of friction

For the purpose of designing the equipment, the coefficient of friction shall not be less than the following:

Equipment	Static friction	Kinetic friction	
	(Starting)	Max. (whichever gives worse case)	Min.
Metal seals	0.6	0.5	0.3
Rubber seals	1.5	0.9	0.6
Brass-faced seals	0.42	0.3	0.2
Fluoro-carbon faced seals	0.2	0.15	0.1
Self-lubricating bearings	0.2	0.11	0.05
Roller wheel bearings	0.015	0.01	0.004

T7.13.11 Mechanical efficiency

For the purpose of designing the hoists for gates and valves, the mechanical efficiency shall not be more than the following value:

Parts	Mechanical efficiency
Spur gear of wheel and pinion per one (1) set (open)	0.95
Bevel gear of wheel and pinion per one (1) set (oilbath)	0.97
Cyclo speed reducer	
reduction ratio 1/59 - 1/11	0.80
reduction ratio 1/87	0.75
reduction ratio not less than 1/121	0.65
Worm reducer	0.50
Sprocket by chain driving (per each)	0.95

T7.14 Detailed Specifications of Intake Gates and Hoists

T7.14.1 General

Three (3) sets of oblique lift, fixed-wheel type intake gate with its guide frame, hoist, controls and appurtenant parts complete with necessary accessories shall be designed, supplied and installed at the intake portion of the dam by the Contractor under this Chapter of the Contract. The intake gates shall be used for shutting off the waterway for supplying water to downstream of the dam. This gate will mainly be used at fully opened position.

The general data for the design of the intake gates are given in sub-clause T7.14.3 "Design data" herein and these data shall be fixed and may not be altered.

The Contractor shall exercise special care in the design and fabrication of the gate to avoid vibration during any operating condition and water leakage under fully closed condition.

The arrangement of the intake gates shall be as shown on the Drawings.

T7.14.2 Design stresses

The design stresses shall conform to those specified in Clause T7.13 "Design Conditions".

T7.14.3 Design data

The gate, guide frame and hoist shall be designed for the following conditions:

(1) General data

Type of gate	:	Steel made fixed-wheel gates
Quantity	:	Three (3) sets
Clear span of gate	:	2,100 mm
Clear height of gate	:	2,100 mm

	Gate No. 1	Gate No. 2	Gate No. 3
Design head :	40.640 m	55.640 m	69.213 m
Sill elevation :	168.360 m	153.360 m	139.787 m
Operation head :	40.640 m	55.640 m	69.213 m

Gradient : 37^{0}-34'-07" degrees

Water filling device : Bypass valve on Gate No. 3 having diameter of 150 mm

Corrosion Allowance : 2.0 mm for all components exposed in water

Water seal of gate : 4 edges rubber seal at downstream face of gate

Maximum hoisting height : 2.5 m

Operation speed : 0.3 m/min. ± 10%

Type of hoist : Electrically operated double screwed spindle type

Operation : Local control at gate control house

(2) Design loads

(a) Gates

(i) Normal load conditions

- Hydrostatic load
- Head water at elevation 209.00 meters.
- Tail water below sill beam.
- Self weight of the gate and spindle
- Operating load of hoist

(ii) Overload conditions

- Inertia force during earthquake
- All loads imposed by the hoist in gate jammed condition during raising operation.

(b) Guide frames

The loading on the guide frame shall be wheel loads and all other loads due to the most adverse operation of the gate and hoist. The guide frames and anchors shall be capable of transferring the loads of the wheels, rubber seals and side rollers of the gate to the concrete structure.

(c) Hoists

The hoists shall be designed to raise, lower and hold the gate in any position between fully lowered and fully raised positions.

The rated capacity of the hoist and its spindles shall be adequate to raise or lower the gate at the specified speed under the following combination of loads:

(i) Normal load conditions

- Raising and lowering the gate under without water flow at any reservoir water level up to design water level of 209.00 m.
- Self weight of the gate and spindles.
- Friction forces of rotating and sliding parts, and rubber seals.
- Buoyancy, uplift force and downpull force

(ii) Overload conditions

The load resulting from the breakdown or locked rotor torque of the hoist motor, whichever is greater.

T7.14.4 Gates details

(1) General

The gate shall consist of skin plate, main beams, wheel assemblies, seals, side rollers, water filling device and all other necessary components. The gate shall be of fixed-wheel type and of all welded construction.

The gate shall be designed to transmit the design load to the main beams without warping or undue deflection and to be operated satisfactorily without vibration under any opening and conditions of flow.

Two (2) sets of U-hooks for holding the gate leaf shall be provided on the top of the gate.

Provision such as air vent and drain holes shall be made to fill water into and to drain water from the gate.

The details of construction of the gate, not specified herein, shall be made by the Contractor upon approval of the PMO/Engineer.

(2) Skin plates

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

(3) Main beams

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

(4) Wheel assemblies

Two (2) sets of wheel assemblies shall be provided on each side of gate to transfer all the loads to concrete structure through the track frame. Each wheel assembly shall consist of wheel, shaft, bearing and other necessary components. The wheel shall be of cast steel or other approved materials. The contact surface of wheel shall be slightly crowned to accommodate gate deflection under loading. The wheels shall be provided with shafts of corrosion-resisting steel or approved material, and self-aligning roller or needle bearing with lubricating system. To provide adjustment of the whole wheel treads, the journal surface of the axle shall be eccentrically located with respect to its end support. By this arrangement, the downstream face of whole wheel treads can be adjusted so that all wheels will bear uniformly on the track frames.

(5) Side rollers

Two (2) side rollers shall be provided on each side of the gates to limit the lateral movement of the gate.

The side rollers shall be provided with self-lubricating bushing with lubricating system and corrosion-resisting steel pins and location washers.

Each roller and pin shall be designed to resist the imposed load due to the gate becoming jammed in the guide frame, with the hoist motor at its locked rotor torque.

(6) Seals

The gate seals shall be of moulded rubber shape clamped to the downstream face of the gate using steel bars and corrosion-resisting steel bolts, nuts and washers. The seals shall be spliced at the corners by shop vulcanizing to provide a single continuous seal. The tensile strength of all shop splices shall not be less than 50 per cent of tensile strength of the unspliced material. The lintel and side seals shall be of the caisson type or other approved shape, activated by the upstream water pressure. The bottom seal shall be a plain bar of rubber which shall bear on the sill beam.

(7) Water filling device

The water filling device shall be equipped on the gate leaf No. 3 and consist of a bypass valve, filling pipe and screen.

The bypass valve shall be of bulkhead type valve having diameter of 150 millimeters and consist of a valve leaf with metallic seal of bronze or corrosion-resisting steel and operation spindle of corrosion-resisting steel. Spindle supports shall be provided on the gate leaf to minimize vibration and to strengthen spindle against buckling force yielded by the gate hoist.

(8) Hanging hook

Each gate shall be fitted with two (2) hanging hooks on the top of gate to hold the gate leaf at the elevation between the maintenance and fully raised positions for engaging and disengaging gate spindle. The hooks shall have ample strength for the purpose. Two (2) sets of 3 ton hooks shall be provided and installed in the primary concrete under this chapter.

(9) Spindle supports

Fixed type spindle supports shall be provided at interval of eight (8) meters in minimum along the slope of dam from intake to the intake gate control house. The spindle support shall be firmly welded to the reinforcement bars in primary concrete by anchor bolts at the accurate positions.

(10) Tolerances

The gates shall be accurately fabricated within the following tolerances:

Portion to be measured	Tolerances (mm)
Gate width	± 5
Gate height	± 5
Gate depth	± 3
Diagonal length difference	± 5
Distance center to center of wheels	± 4
Distance between wheel treads	± 5
Distance between side roller treads	± 5
Position of side rollers	± 5
Distance between side rubber seals	+ 10, -6
Distance between lintel and bottom seals	± 5
Distance between downstream face of wheel and surface of side rubber seals	+ 2, 0

The tolerances not specified herein shall be determined by the Contractor and subject to the PMO/Engineer's approval.

T7.14.5 Guide frames details

(1) General

The guide frame shall consist of the sill beam, track frames, side guide frames, lintel beam and all other components necessary for the complete and satisfactory installation of the guide frame. The corrosion-resisting steel plates shall be attached to all exposed surfaces of guide frames to avoid excessive wear thereof.

The details of construction of the guide frame, not specified herein, shall be made by the Contractor upon approval of the PMO/Engineer.

(2) Sill beam

The sill beams shall be straight and true for providing a close fit with the bottom of the gate leaf. The sill beam shall be conservatively designed to be able to transfer all loads applied to it to the concrete structure.

(3) Track frames

The track frames shall be capable of transmitting the water load from the wheels to the concrete structure. The tread surfaces of the track frames shall be furnished with corrosion-resisting steel plates of not less than 9 millimeters thick, and be true to form and flat. The surfaces shall be suitably machined and have the hardness rather higher than that of the wheels of the gate to prevent excessive wear.

(4) Side guide frames

The side roller paths and frames shall have ample strength to resist the load of the side rollers. The assembled side roller paths shall be straight over their entire length and no offset shall exist at joints. The side roller paths shall be of corrosion resisting steel.

(5) Lintel beam

The lintel beam shall have ample strength and have the sealing plate made of corrosion-resisting steel. The lintel beam shall be true to form and free from twist and warp to provided a watertight seal with the gate lintel seal. Armored plate against erosion shall be provided on the beam.

(6) Tolerances

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

Points to be measured	Tolerance (mm)
Clear span	± 5
Clear height	± 5
Diagonal length difference	± 5
Distance center to center of track frames	± 5
Height of guide frame	± 7
Distance between side roller paths	+ 8, 0
Flatness of lintel sealing frames	± 0.5/m
Straightness of lintel sealing frames	± 2
Flatness of side sealing frames	± 0.5/m
Straightness of side sealing frames	± 2
Flatness of sill beam surface	± 0.5/m
Straightness of sill beam surface	± 3

Flatness of track frame surface	± 0.5/m
Straightness of track frame surface	± 1
Straightness of side roller paths	± 2

The tolerances not specified herein shall be determined by the Contractor, subject to the PMO/Engineer's approval.

T7.14.6 Hoists details

The hoist shall be electrically operated double screwed spindle type hoist and suitably mounted on the steel base frame with anchor bolts at approximately EL. 197 meters to raise, lower and hold the intake gates in any position between fully lowered and fully raised position.

The hoist shall consist of steel base frame work, mechanical equipment, i.e., bearings, gear reducer unit, couplings, screwed spindle, hoisting spindles, manual operating device, mechanical handle slipping device, mechanical position indicator, etc., electrical equipment, i.e., motor, equipment for control and wiring and all other necessary components for safe, proper and efficient operation of the hoist. Anchor bolts to be provided under this chapter shall be welded to reinforcement bars and fixed to steel template for concrete placing.

The mechanical handle slipping device shall be provided on each hoist. The slipping device shall consist of torque limiter coupling, bearing units, shaft, brackets and all other necessary components for safe and proper operation of the hoist.

The hoist shall be designed to withstand the maximum hoist load at the specified allowable unit stress and the factor of safety. The spindle shall be of corrosion resisting steel and or steel pipe. The minimum diameter of spindle shall be 90 millimeters and nominal diameter of 100 millimeters with thickness of 6 millimeter for solid and hollow materials respectively. The spindles shall be connected each other through bolted spindle joints.

The mechanical and electrical equipment shall conform to the requirements of sub-clause T7.4.14 "Mechanical equipment and parts" and Clause T7.5 "Electrical Equipment and Parts" respectively.

The details of the construction of the hoists, not specified herein, shall be made by the Contractor upon approval of the PMO/Engineer.

T7.14.7 Control and wiring

(1) General

The Contractor shall supply and install necessary control cabinet and distribution board for operation and control of the intake gates. The power for control of the gates shall be supplied to the local control cabinet through the gate distribution board to be provided in the gate control house under this chapter of the Contract.

Each gate hoist shall be operated through a local control cabinet. The hoist shall be capable of raising, lowering and holding the gate by corresponding push-button switches on the control cabinets.

The following limit switches shall be provided on each hoist for proper operation of the gates :

(a) "Fully raised" and "Fully lowered" limit switches to stop the gate at the respective restricted positions,

(b) "Bypass valve opened" limit switch to stop the gate at the fully opened position of bypass valve, and

(c) Manual operation interlocking limit switch to de-energized the electrical control circuit.

(2) Wiring

The power and control cables and/or wires with all necessary conduits and accessories from the dam distribution board in the gate control house to the respective electrical equipment, which are necessary for the required proper operation of the gates, shall be supplied and installed by the Contractor. Wiring system shall be as shown on the Drawings.

(3) Distribution board

A distribution board shall be provided in the gate control house to operate and to control the gates. The board shall have sufficient capacity and necessary components for proper operation and control shall be included in the board.

(4) Control cabinets

The Contractor shall provide one (1) local control cabinet for operation of three (3) gate hoists. The local control cabinet shall be located on the floor of gate control house. The control cabinet shall conform to the requirements of sub-clause T7.5.6 "Control cabinet and panel". All necessary switches, indicators, relays, transformers, and other devices shall be installed within each cabinet.

The following instruments shall be mounted on or within local cabinet:

- Incoming supply Moulded Case Circuit Breaker (MCCB) lockable in "OFF" position,
- Earth leakage relay,
- Starter for each motor,
- Source volt meter,
- Three (3) sets of load ammeter,
- Three (3) sets of motor protection relays,
- 230 volts convenience outlet,
- Fluorescent light with door switch,
- Space heater to prevent moisture condensation, with thermostatic switch,
- Three (3) sets of "Raise", "Lower" and "Stop" push-button switches,
- One (1) set of "Bypass valve open" push-button switch,
- One (1) set of "Lamp Test" push-button switch for inspection of all indicating lights,
- One (1) set of Source pilot light,
- Three (3) sets of "Fully Raised" indicating lights.
- Three (3) sets of "Fully Lowered" indicating lights,
- One (1) set of "Bypass Valve Opened" indicating light for bypass valve for gate No. 3,
- Three (3) sets of "Raising" indicating lights,

- Three (3) sets of "Lowering" indicating lights,

- Three (3) sets of "Abnormal" indicating light for instruction or abnormal condition,

- One (1) set of "Earth leakage" indicating light,

All other necessary instruments required for proper operation of the intake gate.

Indicating lights for "Raising", "Lowering", "Abnormal", and "Earth Leakage" shall be capable of flickering during lighting.

T7.14.8 Shop assembly and tests

(1) Gates and guide frames

Each gate including wheels, seals and side rollers etc. shall be assembled at the shop in the approximate position that it will have after installation at the Site. While assembled, the gates shall be checked for dimension, tolerances and accuracy of alignment. Any error and misalignment discovered shall be promptly corrected.

The track frames, side roller paths, sealing frames, sill beams and lintel beam shall be assembled at the shop and all dimensions, flatness, straightness, etc. of the guide frames shall be checked and any error and misalignment discovered shall be corrected.

Parts shall be clearly match-marked before disassembling for shipment.

(2) Hoists

Each hoist shall be completely shop assembled and tested for smooth and proper performance. All units shall be tested at normal operating speed with the rated load and closely checked to ensure that all necessary clearance and tolerance have been provided and that no binding occurs in any moving part. All bearings shall be carefully checked up to their saturated temperature rise under the normal loading condition. All equipment/facilities including temporary power cables, lubricating grease and oil required for the performance of the test shall be furnished by the Contractor.

The following items, at least, shall be checked under the rated hoisting load during the operation test of the hoists upon incorporating the control cabinet to the hoist with temporary wiring:

- Raising and lowering speeds,
- Voltage and current of electric motor,
- Temperature rise of bearings, motor and gear reducer,
- Gear tooth contact,
- Existence of abnormal noise and vibration,
- Manual operation of hoist,
- Operation of limit switches,
- Accuracy of gate position indicator,
- Insulation resistance of control cabinet, and
- Appearance and overall performance of control cabinet.

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

T7.14.9 Installation and tests at site

(1) Guide frames

The guide frames shall be assembled in the blockouts in accordance with the "FOR WORK 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.

Connection between guide frames, anchor 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 bracings shall be provided where necessary to ensure the required alignment.

Extreme care shall be taken to ensure that the wheel paths and sealing surfaces lie in a true plane within the tolerances specified for their entire length. Placement of concrete in the blockouts shall not proceed until the guide frames have been completely assembled and

secured. During and after concrete placing, alignment and tolerances shall be checked and remedial action taken if readings indicate that displacement has occurred.

(2) Gates

The gates complete with seals shall be assembled and erected in accordance with the "FOR WORK DRAWINGS" within the tolerances specified. Joints shall be watertight where required. The rubber seals shall be fixed on each gate leaf and adjusted to have effective water tightness on the sealing frames of the guide frame.

(3) Hoists

Before assembly, all bearing surfaces, journals, 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 the approved lubricant furnished by the Contractor.

Each hoist, complete with all accessories, shall be assembled and installed in accordance with the "FOR WORK DRAWINGS" within the tolerances specified.

After installation of the hoist and prior to connecting the spindles, the hoist shall be operated and checked for proper operation. After completion of the above test, the spindles shall be connected to the gate and the gate shall be tested, at which time all controls such as limit switches and position indicator, etc., shall be adjusted and tested for proper operation. Any defect or improper operation discovered during the test shall be corrected and the entire test repeated.

T7.14.10 Tests on completion

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

(1) Preliminary tests

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

- Inspection by feeler gauge measurement for satisfactory sealing of all seats.
- Insulation resistance tests on all wirings and connections made at site.
- Inspection of satisfactory installation of all components.

(2) Operation tests

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

- Measurements of operation speeds, voltage and current of electric motor.
- Check of water leakage.
- Check of manual operation of hoist.
- Check of limits of travel, accuracy of indication and limit setting.
- Check of satisfactory operation under dry condition and an acceptable water level.

(3) Water leakage test

Water leakage tests shall be performed concurrently with the operation test under an acceptable water level. Jetting or concentrated leakage at any localized point shall not be permitted, even if less than the permissible water leakage rate. The seals at such location shall be adjusted as necessary.

The maximum permissible water leakage rate at any one meter for each gate irrespective of the hydraulic pressure shall be 0.2 liter/sec, however, the total permissible water leakage from seals of each gate shall not exceed 4.0 liter/sec.

Any defects or improper operation discovered shall be corrected at once and entire test shall be repeated to the satisfaction of the PMO/Engineer.

T7.15 Detailed Specifications of Intake Trash Racks

T7.15.1 General

Each three (3) sets of front and top fixed trash racks shall be designed, supplied and installed in front of the every intake gates and the top of gate slots respectively by the Contractor under this chapter of the Contract. The trash racks shall be designed to prevent the entrance of matters injurious to the water supply facilities, such as discharge and guard valves and water turbine(s) which will be installed in future, and to withstand adequately the static and other loads, and to avoid vibration phenomena which are likely to occur due to flow of water passing through the trash racks.

The general data for the design of the trash racks are given in sub-clause T7.15.3 "Design data" herein and these data shall be fixed and may not be altered.

The arrangement of trash racks shall be as shown on the Drawings.

T7.15.2 Design stresses

The design stresses shall conform to those specified in Clause T7.13 "Design Conditions".

T7.15.3 Design data

The trash racks shall be designed for the following conditions:

(1) General data

Type	:	Fixed type	
		Front trash rack	Top trash rack
Quantity	:	Three (3) sets	Three (3) sets
Clear span	:	3.00 m	3.10 m
Height/width	:	3.00 m (Inclined height)	0.9 m (Width)
Bar pitch	:	75 mm (center to center)	
Design head	:	A water head difference of 2.00 m	

(2) Design loads

(a) Trash rack panels

Design head difference of 2.00 m.

Dead weight of trash rack panels

T7.15.4 Trash racks details

(1) General

The trash racks shall consist of bar elements, supporting frames and all other necessary components. The trash rack panel shall be fixed on the supporting frames using corrosion-resisting bolts, nuts and washers.

The details of construction of trash racks, not specified herein, shall be made by the Contractor upon approval of the PMO/Engineer.

(2) Bar elements

The bar elements of the trash rack panel shall be of rectangular section bars. All bar elements shall be transversely connected with tie bolts, nuts and spacing pipes and rigidly fixed on the supporting frames.

(3) Tolerances

The trash rack panels shall be accurately fabricated and installed in accordance with the "FOR WORK DRAWINGS" within the following tolerances:

Points to be measured	Tolerance (mm)
Panel width	± 5
Panel height	± 5
Diagonal length	± 5
Bar pitch	± 3
Straightness of bar elements	± 1/m
Lateral flatness of screen face	± 2/m

The tolerances not specified herein shall be determined by the Contractor, subject to the PMO/Engineer's approval.

T7.15.5 Shop assembly and tests

The trash racks shall be shop assembled and checked for dimensions, tolerances and accuracy of alignment. Any error or misalignment discovered shall promptly be corrected.

T7.15.6 Installation and tests at site

The supporting frames shall be installed in their blockouts in accordance with the "FOR WORK 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 supporting frames accurately. Placement of concrete in the blockouts shall not proceed until the frames have completely been installed and secured.

The trash rack panels shall be installed in accordance with the "FOR WORK DRAWINGS" within tolerances specified.

T7.15.7 Tests on completion

After completion of the installation work at the Site, the Contractor shall perform the following tests, but not be limited to:

- Inspection of satisfactory installation of all components,

- Sampling inspection on the pitch of bars,

Any defect discovered shall be corrected and entire test shall be repeated to the satisfaction of the PMO/Engineer.

T7.16 Detailed Specifications of Water Supply Facilities

T7.16.1 General

One complete set of the steel conduit, discharge valve and guard valve shall be designed, and supplied and installed in the valve chamber and in the diversion tunnel. The water supply facilities

shall be used to discharge water to the downstream of the dam through the discharge valve for municipal water supply at present. The conduit will be connected to steel penstocks to lead water to the hydro power scheme in future.

The steel conduit shall consist of a straight pipes, bell mouth, seepage rings, stiffeners, thrust rings, manhole, drain system with all necessary components.

The discharge valve shall consist of a hollow jet valve with hydraulic hoist, oil pressure piping, controls and air relief valve with all necessary components. The valve shall be installed at the end of the steel conduits.

The guard valve shall consist of a circular section high pressure gate valve with hydraulic hoist, oil pressure piping, bypass valves with all necessary components. The valve shall be installed in front of the discharge valve to shut off the water flow when the discharge valve is not in service or is required for inspection and maintenance. The valve shall be at either fully opened or fully closed positions and operated under subsequently balanced condition, but shall be capable of shutting off water flow at any water head when the discharge valve cannot be closed.

The valves shall be operated and controlled from the remote and local control cabinets to be specified in Clause T7.17 "Detailed Requirements of Operation and Control" The valve will be dismantled when the steel conduit is required to connect with steel penstocks for future hydro power scheme.

The Contractor shall exercise special care in the design of the conduit on extension to the future hydro scheme. The general data for the design of the conduit are given in sub-clause T7.16.3 "Design data" and these data shall not be altered. The arrangement of the water supply facilities shall be as shown on the Drawings.

T7.16.2 Design stresses

The design stresses shall conform to those specified in Clause T7.13 "Design Conditions".

T7.16.3 Design data

The water supply facilities shall be designed for the following conditions:

(1) Steel conduit

Type of conduit	:	Embedded steel conduit
Quantities to be provided:		
Steel conduit	:	1 lane
Drain system	:	1 set
Diameter of conduit	:	1,500 to 400 mm
Length of conduit	:	210.207 m
Diameter of drain system		
for steel conduit of 1,500 mm	:	200 mm (nominal)
for steel conduit of 400 mm and guard valve	:	50 mm (nominal)
Diameter of manhole	:	600 mm
Internal design head	:	90.00 m
External design head	:	80.00 m
Grout pressure	:	2.5 kgf/cm^2
Corrosion allowance	:	2.0 mm for encased conduits
Welding efficiency	:	95 % at shop and 90 % at site wdld

(a) Axial forces

The conduit shall be capable of resisting the following axial forces and/or other forces that the Contractor shall foresee as an essential element of the design:

(i) Local stress due to restraining the pipe shells expansion by stiffener rings if provided,

(ii) Stress due to axial component of internal pressure at reducing pipe,

(iii) Stress due to axial component of internal pressure at the discharge and guard valves at its closure,

(iv) Stress due to variation of temperature of pipe (20 ^{o}C during the water filling), and

(v) Stress due to Poisson's effect.

(b) Loads due to handling during fabrication, transportation and field erection

The shell thickness of conduit shall not be less than the thickness necessary for handling, as determined by the following empirical formula:

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

where,

t : Minimum shell thickness (mm), but shall not be less than 6.0 mm

D : Inside diameter (mm)

(2) Discharge valve

Type of valve	:	Hydraulically operated hollow jet valve
Quantities to be provided	:	One (1) set
Diameter of valve	:	400 mm
Design head	:	80.00 m
Valve center elevation	:	EL. 129.016 m
Water seal of valve	:	Metallic seal on plunger and valve body
Type of hoist	:	Hydraulic servomotor
Operation head	:	80.00 m
Operation speed	:	0.1 m/min. ± 10%

Operating oil pressure	:	70 kgf/cm^2
Maximum discharge	:	1.0 m^3/sec at 9.984 m head
Discharge coefficient at full opening	:	0.8 or more
Operation method	:	Local control in valve chamber of diversion tunnel and remote control from dam control house

(3) Guard valve

Type of valve	:	Hydraulically operated high pressure gate valve
Quantity	:	One (1) set
Diameter	:	400 mm
Design head	:	80.00 m
Valve center elevation	:	EL. 129.016 m
Water seal of valve	:	Metal touch seat
Type of hoist	:	Hydraulic servomotor
Operating head		
Normal	:	Under balanced water head condition
Emergency	:	80.00 m
Operating speed	:	0.1 m/min. ± 10%
Operating oil pressure	:	70 kgf/cm^2
Diameter of bypass system	:	50 mm (nominal)
Operation method	:	Local control in valve chamber of diversion tunnel and remote control from dam control house

In addition to the above, the erection load due to its own weight, all loads imposed during starting, opening or closing the valve shall be considered on the design of each valve.

T7.16.4 Steel conduit details

The steel conduit shall be of circular section and consist of steel conduits, reducing pipe, bell mouth, seepage rings, stiffener rings, thrust rings, grout holes and plugs, manhole, manhole covers, a steel cover, a pit cover, dismantling joint at downstream side of the guard valve, matching flanges, drain system and other necessary components for proper operation, maintenance and services.

The conduit and reducing pipe shall be fabricated from carbon steel plates specified in Clause T7.12 "Materials".

The exposed reducing pipe having internal diameters of 1,500 millimeters and 400 millimeters shall be provided in the valve chamber.

The bell mouth shall be provided at the inlet of the conduit to reduce hydraulic loss due to inflow friction to the conduit.

Necessary numbers of the seepage rings shall be provided at upstream part of the conduit to minimize leakage water through gaps between secondary concrete and the conduit.

The required size and numbers of stiffener rings shall be provided on the surface of conduit to reinforce strength of conduit shell against buckling force due to the specified external pressure.

The required size and numbers of thrust rings shall be provided on the conduit to transfer thrust force yielded by closure of discharge and its guard valves and reducing pipe.

The grout holes and plugs having diameter of 1-1/2 inches for contact grouting between secondary concrete and conduit shall be provided at lower half of the conduit at plug concrete portion as shown on the drawings.

The manhole shall be provided at the upstream side of guard valve. The manhole shall consist of steel manhole cover and riser pipe. The riser pipe shall be of JIS G 3454 (STP) of the carbon steel pipes for pressure service. The manhole cover shall be equipped on the top of the riser pipe and be tightened with bolts and nuts of the corrosion-resisting steel. Adequate size of reinforcement plate shall be provided on the steel conduit at the connecting point of manhole riser pipe. Water seal

between the flanges of riser pipe and blind flanges shall be made by the O-ring of neoprene rubber. A steel cover shall be provided on the recess on anchor block for each manhole. The cover shall be of checkered plate with ribs and embedded corner angles.

A steel pit cover shall be provided on the drain valve pit for the river outlet facilities with corner angles. The pit cover shall be of checkered plate with ribs and embedded corner angles. Two (2) edges of the corner angle shall be embedded in floor concrete and others shall be fixed on the concrete wall of valve chamber by hole-in-anchor bolts.

The dismantling joint shall be provided at the downstream side of guard valve for removal of the valve for service and maintenance. Matching flanges for the guard valve, discharge valve, bypass valves and pipes and drain system shall be provided on the respective positions for connection of these valve with the conduit.

The drain system shall consist of drain valves and drain pipe to discharge trapped water in the water supply steel conduit and leakage water from the guard valve. The drain system for the steel conduit of 1,500 millimeters in diameter shall consist of steel pipes and serially connected valves having nominal diameter of 200 millimeters. Each drain system for steel conduit of 400 millimeters in diameter and from the lower bonnet of guard valve shall consist of a valve and steel pipe, having nominal diameter of 50 millimeters and these pipes shall be connected to the drain pipe of 200 millimeters in diameter. The valves and pipes shall be of the 10 kgf/cm^2 cast steel flanged gate valves (outside screw type) of JIS B 2071 and the carbon steel pipes for pressure service of JIS G 3454 respectively.

T7.16.5 Fabrication of steel conduits

(1) General

The Contractor shall cut the plates for the steel conduits to exact dimensions, prepare the edges for welding, press the edges for rolling, roll them to the required curvatures and make them to the complete sections at the Contractor's shop. The steel materials to be used for the steel conduits shall be clearly marked for easy identification of their kinds.

(2) Cutting and bending

All plates shall be cut accurately to the dimensions shown on the FOR WORK 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 section, 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 not be permitted. For butt welding of plates of unequal thickness, the work of trimming of the thicker plate shall be done in the Contractor's shop as to have a taper of 1 : 4, if the difference between plate thickness is more than 3.0 millimeters. The orientation of the plate for fabrication shall be such that the final direction of the plate for fabrication shall be such that the final direction of rolling is placed circumstantially. No stamping or groove marking on the steel conduit shall be allowed, if it puts to part other than cutting line for fabrication purpose or leaves on the finished steel conduit surface.

Bending of plates shall be performed by cold working as a rule. If bending is made by hot working, the Contractor shall obtain the approval of the PMO/Engineer for the temperature control procedure.

(3) Welding

In addition to the welding requirements specified in sub-clause T7.4.11 "Welding", the following shall also govern:

(a) Cleaning before welding

The surface of plates to be welded shall be cleaned from all scale, rust oil, paraffin or grease, for a distance of not less than 25 millimeters from the welding edge. Welding grooves shall similarly be cleaned.

(b) Cleaning after welding

When the steel penstock is completely erected ready for concreting, there shall be no lugs, cover plates, saddles or other devices welded to the steel conduit shell, except where these form parts of the permanent support of the steel conduits for concreting. All temporary lugs and device welded to the external surface of the conduit shell shall be carefully removed by the Contractor and 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 conduit shell. After concreting is completed, all internal bracings and devices welded to the interior surface of the steel conduit shall be similarly removed and the surface shall be dressed smooth and flush.

(c) Lugs, saddles or brackets

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

(d) Reinforcement of welding metal

All welded joints shall be dressed smooth and the maximum reinforcement shall be limited to the tolerances on the interior surface of steel conduits as shown below. On the external surface of the conduit, welds shall be dressed free of all flux and scale and smooth to the extent necessary to allow radiographic examination.

Plate thickness (mm)	Tolerances (mm)
Under 12	1.5
12 to 25	2.5
Over 25	3.0

(e) Thrust collars, seepage rings, stiffener rings, reinforcement rings for grouting holes, manholes, etc.

Thrust collars, seepage rings, stiffener rings, reinforcement rings for grouting holes, manholes, etc. shall be welded on the conduits shells at the Contractor's workshop or field shop, and shall be made of the same plate material with the shell proper.

(f) Core wires, fluxes and welding rods

Core wires, fluxes and welding rods shall be of the most suitable materials for the base metals and shall be kept under sufficient dry condition. The Contractor shall obtain the approval of the PMO/Engineer, in cooperating their kind, characteristics, weldability and control procedure into welding procedure.

(g) Back chipping

Back chipping for welded joint shall be performed by arc-air gouging.

(h) Shelters

If welding work is performed under the condition of windy, wet or hot weather, suitable protecting facilities shall be provided for the welding work.

(4) Tolerances

The completed steel conduit shall conform to the dimensions shown on the Drawings and to the tolerances specified herein. The tolerances of circumferential length of each section shall not exceed plus or minus 0.25 per cent of the design length for that section.

The end 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 of bends shown on the approved drawings shall be within a tolerance of plus minus 10 minutes of angle. Edges of adjoining plates to be welded shall match with a maximum allowance offset at any point of 2.0 millimeters. The conduit sections shall be aligned so that their center lines are within plus minus 5.0 millimeters of the true center line. The tolerances listed are exclusive of any allowance for shrinkage or distortion provided by the Contractor to compensate for effects of welding.

T7.16.6 Discharge valve details

(1) General

The discharge valve shall be of the hollow jet valve type and consist of upstream body, downstream body, needle, seals, position indicating system and all other necessary components. The inner cylinder in the downstream body shall be centrally positioned by four or more equally spaced radial splitters with their downstream ends left closed. This shall permit free access of air to the interior of the hollow jet through the slits of the jet itself caused by splitters. The interior parts of the valve shall be arranged that the needle, needle supports and gears together with the operating mechanism, are assembled as a complete unit. The needle shall be moved at the rated speed along the center line of the body by the oil pressure operated by an oil pressure unit. The valve shall be provided with a position indicator. An air relief valve shall be provided at upstream side of the discharge valve to supply air during discharging water in the conduit between the discharge valve and the guard valve.

The details of construction of the valve not specified herein will be left to the Contractor, subject to approval by the PMO/Engineer.

(2) Upstream body

The inner surface of the upstream body shell shall be cast with sufficient excess shell thickness to permit finishing to the required dimensions. Final machining of this surface shall not be done until the corrosion-resisting steel seat has been deposited. Care shall be exercised in the layout, drilling and tapping of the bolt holes in the upstream flange. After shop assembly of the upstream body to the downstream body, the inside curved surface of the upstream body shall carefully ground to produce a smooth, continuous surface at the flanged joint of both bodies.

(3) Downstream body

The plates for the downstream body shall be cut accurately to size and shape. The edges to be jointed by welding shall be formed properly to suit the selected type of welding and to allow complete penetration. Curved plates shall be bent or rolled to true circular sections with curvature continuous from the edges of the plate. No correction of curvature by hammering shall be employed. Care shall be exercised when the outer shell welds to the upstream flange to avoid any offsets between the inside surface of the outer shell and the bored surface of the flange. The stiffener rings at the downstream end of the body and at the upstream end of the inner cylinder may be fabricated from segments joined by full strength butt welds ground flush.

(4) Plunger

The longitudinal joints of the plunger shall be welded. The corrosion-resisting steel weld of 3 millimeters in thickness shall be made. The surface shall be dense and homogeneous, free from slag, carbon steel, or gaseous inclusions, with the layers well-bonded to each other and to the base metal.

(5) Needle

The upstream surface of the needle shall be cast with sufficient metal to permit finishing to the required dimensions. Final machining of this surface shall not be done until the corrosion-resisting steel seat has been deposited.

(6) Air relief valve

An air relief valve shall be provided between the discharge and guard valves to supply air during discharging water in the conduit of the above section. The air valve shall be opened automatically by the action of gravity. The valve shall be of coil spring balanced float type with a dashpot.

The valve shall be sized to supply enough air to limit the effective water head difference to 2.0m between inside and outside of conduit to avoid its buckling when the guard valve is under emergency closing conduition.

Diameter of the air relief valve shall be determined by the Contractor upon approval of the PMO/Engineer.

T7.16.7 Guard valve details

(1) General

The guard valve shall be of circular section gate valve and operated by hydraulic servomotor. The guard valve shall consist of the valve leaf, valve body, hydraulic servomotor and all other necessary components. The valve shall be capable of discharging water under the specified water head condition without unacceptable vibration, cavitation and excessive wear. The valve shall be connected to the drain pipe by means of flange connection and shall consist of valve leaf, valve body, valve seat, operating device, bypass valves and pipes, and all other necessary components. The bypass system shall be provided at the guard valve to equalize the water pressure at both sides of the valve. The mechanical locking device shall be provided on the top of servomotor to maintain the fully opened position of the guard valve. The locking device shall be capable of disengaging by pressing "Open" push button switch on the control cabinets by hydraulic pressure produced by the oil pressure unit.

Maintenance ladder and step of steel construction shall be provided to the valve for inspection and service of the guard valve.

The details of construction of the valve not specified herein will be left to the Contractor, subject to approval of the PMO/Engineer.

(2) Valve leaf, valve body and seats

The valve leaf shall be of all welded or cast steel construction. The valve leaf, fluidway and seal seat portions of the valve shall be of robust and rigid construction so as to prevent occurrence of vibration and cavitation during the valve operation. The deflection of valve leaf shall be such that there shall be no leakage under full load condition and all parts of valve leaf shall have a corrosion allowance of 2.0 millimeters when mild steel plate will be applied to the valve leaf.

The bronze seal plates shall be provided in the valve body to form sealing seats and sliding way upon which the vertically moving valve leaf is supported and seated. The bronze seal plates shall be fastened with flat-head bronze screw on downstream side of valve leaf.

The valve body shall be of all welded of cast steel construction. The body shall consist of frames, a bonnet and a bonnet cover. The body shall have the sufficient strength against maximum water pressure and forces due to concrete placement, and have a corrosion allowance of 2.0 millimeters. The frame and bonnet shall be bolted together where their adjacent mating vertical flanged faces are brought into water tight engagement. They shall be arranged to form a vertical slot in the walls on each side of the fluidway, within which the valve leaf is received, supported, and guided in its opening and closing movements. The frames shall be bolted by both side flanges of steel conduits. The bottom of valve body shall be left free and have the drainage system to avoid matters injurious to water sealing of the vale leaf under the fully closed condition. Gasket materials, bolts and nuts shall be furnished for all flanged connections.

(3) Hydraulic servomotor

The hydraulic servomotor shall be of vertical cylinder type and shall be capable of raising the dead weight of valve leaf, plus stem and piston, and lowering the above dead weight, plus downpull force due to full water flow, by either oil pressure unit or by hand in case of shortage of electric power, and shall consist of cylinder, cylinder head, piston, stem and all other necessary components.

The servomotor shall be adequate to open, close and hold the valve leaf under the given design head and operation requirements. The stem shall be made of corrosion-resisting steel and be fixed to the valve leaf by the suitable nuts. The stuffing box consisting of the first grade of graphited flax or of the built up chevron type shall be used to the parts for preventing the escape of water from the interior of the bonnet. The piston shall be made of

oil tight by means of suitable piston rings. The servomotor shall be equipped with the catching device for piston when the valve leaf is in the fully raised position.

The mechanical and electrical equipment shall conform to the requirements sub-clause T7.4.14 "Mechanical equipment and parts" and Clause T7.5 "Electrical Equipment and Parts".

(4) Bypass system

The bypass system shall be provided to equalize a water pressure between upstream and downstream sides of the guard valve for operating under the balanced water head condition.

The bypass valve system shall consist of manually operated bypass valve and pipes. The valves and pipes shall conform to the requirements in sub-clause T7.16.5 "Fabrication of steel conduits".

T7.16.8 Tests and inspections for conduit

(1) Mill tests

The steel plates for the steel conduits shall pass the following mill tests in accordance with the requirements of JIS G 0303 for each thickness and each quality:

(a) Tension test,

(b) Bend test,

(c) V-notch charpy impact test (applicable for the material SM41B or equivalent or above), and

(d) Chemical analysis.

Certified copies of mill test reports shall be furnished to the PMO/Engineer as soon as possible after the tests are made. The results of test shall be submitted in the form that provides means of determining compliance with the applicable specifications for the materials tested. When requested, all test or trial shall be made in the presence of the inspector appointed by the Employer and/or the PMO/Engineer.

(2) Radiographic examination

One hundred (100) per cent of longitudinal joints and twenty (20) per cent of girth joints including all T-parts in the pipe shell shall be radiographed at the Contractor's workshop, field shop and at the site.

Radiographs shall be in accordance with the requirements and technique of JIS Z 3104 and be passed over or equal to Grade 2. Objectionable defect in welds shall be chipped or flame or arc-gouged at least in a film to show sound metal and the defect shall be rewelded. If the objectionable defect is discovered in the girth joints, it shall be repaired in accordance with the following procedures:

(a) A film length weld line of both sides of the defect portion, shall be radiographed to examine whether there is the objectionable defect therein or not.

(b) If there is the defect therein, all weld line of joint concerned shall be radiographed and all the objectionable defect shall be repaired.

(c) If there is not the defect therein, the defect portion shall be repaired.

Welds that have been repaired shall be one hundred (100) per cent radiographed again. The Contractor shall furnish all equipment, films and labors necessary to perform the radiographic tests. All original films of the radiographs shall become the property of the Employer. 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 shall be prepared.

(3) Tests of weld 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 x 300 millimeters minimum made up with two 400 x 150 millimeters plates by weld.

The following tests shall be carried out on every plate thickness in accordance with the requirements of the approved standards.

(a) Two tensile test transverse of the weld axis,

(b) Two root bends, and

(c) Two face bends.

(4) Inspection

The steel conduits shall be inspected by the PMO/Engineer for welding and surface imperfections such as undercut welds, stamps, 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 PMO/Engineer's entire satisfaction. Material which shows defect subsequent to erection shall be rejected and the Contractor shall replace the material with new one to the satisfaction of the PMO/Engineer. The peeling, pinhole and thickness inspection shall be performed for the dried films of the painted materials, along with visual check at the Contractor's shop, field shop and at the Site. However, peeling inspection shall not be applied for the portions painted after site welding work. A record shall be maintained of the location of all imperfections and the corrective measures taken to effect repairs.

T7.16.9 Shop assembly and test for valves

(1) General

The discharge and guard valves including hydraulic cylinder hoist and pipings shall be completely assembled in the workshop of the Contractor and tested as described hereinafter to ensure that all parts are sound, fit and operated properly. The Contractor shall furnish all test records and results to the PMO/Engineer upon completion of the tests.

(2) Discharge valve

(a) Assembly

The valves may be assembled with the center line vertically, but all operating test and checking of the needle seat contact shall be made with the valve center line in the horizontal position. During assembly of the valve, special care shall be exercised to be sure the packings are properly fitted and are not damaged. Immediately after the oil cylinder of the downstream body has been finished, the inside surface of the cylinder shall be given a coat of rust-preventing compound and both ends of the cylinders shall be covered until shop assembly.

(b) Operating test

The Contractor shall operate the valves through several complete opening and closing cycles and check to be sure that the valves operate smoothly without any evidence of sticking or binding.

(c) Upstream body and needle pressure test

Before the upstream body or upstream face of the needle is painted, a bulkhead for testing shall be bolted to the flange of the upstream valve body, and with needle held closed by the operating device, all air shall be vented from the bulkhead and water pressure shall be applied and raised slowly to 1.5 times of the foregoing maximum design head. The pressure shall be held for 1/2 hour while the body downstream portions of the needle are examined for leaks. During the test, the leakage past the needle seat shall be measured and shall not exceed 200 cc per 1/2 hour. A record of the actual leakage shall be furnished to the PMO/Engineer.

(d) Leakage test

After completion of assembling, water pressure shall be applied and raised slowly to a pressure equivalent to 1.5 times of the maximum design pressure. The pressure shall be held for not less than 10 minutes. During the test, the leakage past the valve leaf seat shall be measured and shall not exceed 0.1 liter/min.

(e) Oil pressure system

Oil pressure test for the hydraulic cylinder including all hydraulic pipings shall be made to demonstrate sufficient strength of the hydraulic units under an oil pressure equivalent to 2.0 times of the maximum design pressure and oil temperature not less that 20 $^{\infty}$C. This condition shall be held for more than 10 minutes. All parts shall be carefully checked for leakage and any oil leakage discovered shall be repaired. Oil leakage past the piston shall be limited to less than 0.5 liter/hr in this test.

(3) Guard valve

The guard valve including servomotor shall be completely assembled in the workshop of the Contractor for inspection and to ensure that all parts fist accurately and are in proper alignment. The valve shall be opened and closed several times by means of the servomotor

and the required adjustment shall be made until the valve operates properly. The seal seats of the body and leaf shall fit and be sufficiently true to plane.

Before the vale is painted, a bulkhead for testing shall be bolted to the flange of the upstream flange of the valve body at fully closed position. All air shall be vented from the bulkhead and water pressure shall be applied and raised slowly to 1.5 times of the foregoing maximum design head. The pressure shall be held for 10 minutes. During the test, the leakage past the valve seat shall be measured and shall not exceed 200 cc per 10 minutes. A record of the actual leakage shall be furnished to the PMO/Engineer.

After completion of assembling, water pressure shall be applied in the same manner in foregoing paragraph. During the test, the leakage past the valve leaf seal shall be measured and shall not exceed 0.1 liter/min.

Oil pressure test for the hydraulic servomotor including all hydraulic piping shall conform to those specified for the discharge valve.

(4) Major test items

The following items, at least, shall be checked during the operation test of the discharge and guard valves:

- Opening and closing speeds,
- Voltage and current of electric motor of pressure oil unit,
- Oil pressure,
- Temperature rise of bearings and motor,
- Existence of abnormal noise and vibration,
- Operation of limit switches,
- Existence of leakage from hydraulic unit,
- Accuracy of position indicator,
- Manual operation of oil pressure unit, and
- Normal condition of control cabinet.

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

T7.16.10 Installation at site

(1) Steel conduit

The installation work shall include storage, transport to the work spot, installation, erection, welding and inspection of the steel conduits in accordance with the FOR WORK DRAWINGS and the approved installation manual. Site fabrication for the conduits may be accepted, if it shall have the effect of reducing the total cost. The Contractor shall submit full information and drawings as to proposed manufacturing facilities, their location, their capacity, space required, etc. with his tender, if he wishes to fabricate the conduit at the site.

Before commencement of the welding work, the Contractor shall provide ventilating facilities in the diversion tunnel.

Anchor bars which are required in the foundation concrete for temporary equipment and installation of the conduits, including lifting hooks, shall be provided under this chapter of the Contract.

The Contractor shall carefully proceed the installation work in accordance with the schedule and the instructions from the PMO/Engineer, as the installation of the conduits is required to keep pace with the progress of related works. The Contractor shall prepare a plan for the order, method and schedule of installation. The plan shall be submitted to the PMO/Engineer for approval. The Contractor shall maintain close relation with the PMO/Engineer and shall co-operate with them for the smooth progress of the entire project works.

The Contractor shall furnish all handling equipment, laborers, materials, rail-guided wagons, rails with fitting materials and anchors, tools, instruments and other equipment required for installation and inspection/tests of the conduit.

The Contractor shall supply and install sufficient interior bracings or spiders to the part where necessary, in addition to those required for welding to maintain the roundness within the specified tolerances until the encasement is completed. The Contractor shall supply and

install sufficient exterior bracings and saddles to resist the loading due to the placing of concrete and grouting, etc.

Anchor bars for supports where required in the primary concrete shall be provided under this chapter of the Contract.

Manual welding at the installation site shall be employed in principle according to the method as specified herein. Matching of field welding on the girth joints shall be carried out with spiders and pad plates or tack weld jigs.

In no case steel conduit sections shall be forcibly jointed. During the welding operations, the centers and distances between edge preparations shall be maintained at their proper positions. Suitable cover shall be provided over the conduits to protect from water fallen on the welding joints during the welding works. Equipment for drying the welding rods shall be provided to ensure that the welders shall use dry welding rods at all times. After field welding, twenty (20) per cent of the entire girth joints including all T-parts in the conduit shells shall be radiographed, and the welding defect shall be repaired as mentioned before.

Spiders shall not be removed without permission of the PMO/Engineer.

(2) Valves

The discharge and guard valves including hydraulic cylinder hoist with pipings shall be assembled and erected in accordance with the FOR WORK DRAWINGS, approved installation manual and the instructions of the PMO/Engineer.

T7.16.11 Test on completion

The Contractor shall, in accordance with the principal plan above, submit the proposed inspection method defining sequence of the inspection, the equipment preparation and inspection procedure to be followed and the detailed procedure for conducting the inspection, etc.

After completion of the entire project works, a water filling and dewatering test shall be done during the commissioning test for the water supply and river outlet facilities. All weld joints and appurtenances shall be examined for leakage and any leakage discovered during the test shall be promptly repaired and/or adjusted. The Contractor shall, at his own expense, do all works for the purposes of repairing all leaks or other defects as discovered during the period of the test.

The test for water supply and river outlet valves, driving unit and controls shall be performed by the Contractor in accordance with the approved test procedure. Any defect or improper operation discovered shall be corrected at one and entire test shall be repeated to the satisfaction of the PMO/Engineer.

The tests for valves shall consist of preliminary test and operation tests.

(1) Preliminary test

The preliminary tests shall include but not limited to:

- Insulation resistance tests on all site installed wiring and electrical connections, and
- Inspection of satisfactory installation of all components.

(2) Operation test

The operation tests shall include but not be limited to:

- Check of oil leakage, limit of travel and operation speeds.
- Check of accuracy of valve opening, accuracy of indication and limit setting,
- Check of manual operating devices, and
- Check of satisfactory operation under dry condition and watery condition including check for water leakage and controls, etc.

T7.17 Detailed Requirements of Operation and Control

T7.17.1 General

The Contractor shall supply and install necessary control cabinet and distribution board for operation and control of the water supply and river outlet discharge and guard valves. The power for control of the valves shall be supplied to the local control cabinet through the valve distribution board to be provided in the dam control house under this chapter of the Contract.

The discharge and guard valves for both water supply and river outlet facilities shall be operated separately by a common use oil pressure unit through a control cabinet to be installed in the valve chamber in diversion tunnel, with the corresponding push button switches.

These valves shall be operated by corresponding push button switches. Limit switches shall be provided to stop the valve operation at fully closed and opened position.

The operation sequence of the facilities shall conform to the following conditions:

(a) Open bypass valves manually,

(b) Open guard valve under balance water head conditions detected by limit switch to be provided on the air relief valve,

(c) Open discharge valve at designated opening after the guard valve is fully opened,

(d) Close bypass valves manually,

(e) Close discharge valve, and

(f) Close guard valve after the discharge valve is fully closed.

T7.17.2 Control cabinet details

The local and remote control cabinets shall be supplied and installed in the valve chamber in the diversion tunnel and at the control room in dam control house respectively. The construction of the cabinet shall conform to the requirements of Clause T7.5 "Electrical Equipment and Parts".

The oil pump shall start automatically by detecting the low pressure in the hydraulic circuit. The guard valve leaf shall be automatically locked at the fully opened position and be disengaged at closing operation of the valve.

Operation from the local control cabinet shall supersede operation from the remote control cabinet by operation of the local - remote change over switch provided on the local control cabinet.

(1) Local control cabinet

The following instruments shall be mounted on the local control cabinet:

For control of valves

1) Incoming supply MCCB lockable on "OFF" position,

2) Source voltmeter,

3) Source pilot light

4) Load ammeter,

5) Position indicators for all discharge valves,

6) Indicating lights and push button switches for valves in quantities for discharge valves and guard valves for water supply facilities and river outlet facilities as tabulated below.

	Water Supply		River Outlet		
Particular	Discharge Valve	Guard Valve	Discharge Valve	Guard Valve	Color
Indicating lights					
a) Fully closed	1	1	1	1	Green
b) Fully opened	1	1	1	1	Red
c) Opening	1	1	1	1	Red
d) Closing	1	1	1	1	Green
e) Trouble	1	1	1	1	Amber
f) Valve locked	Nil	1	Nil	1	Red
g) Pressure balanced		1		1	Green
Push button switches					
a) "Open"	1	1	1	1	
b) "Close"	1	1	1	1	
c) "Stop"	1	1	1	1	
d) "Lamp test"			1		

7) 230 volts convenience outlet,

8) Change over switch for remote - local operation,

9) Earth leakage relay, and

10) All other necessary relays, contactors, switches and miscellaneous components.

For oil pressure unit

1) Load ammeter,

2) Starter for motor,

3) Indicating lights for oil pressure unit are as tabulated below.

Indicating lights

a) Main pump operating,
b) Standby pump operating,
c) Normal pressure,
d) Low pressure, and
e) Trouble

4) Change over switch for operation of main - standby oil pressure pump,

5) One (1) set of oil pressure gauge,

6) MCCB to protect the control circuit, etc., and

7) All other necessary relays, contactors, switches and miscellaneous components.

Indicating lights for "Opening", "Closing", "Low pressure", and "Trouble" shall be capable of flickering during lighting.

(2) Remote control cabinet

The following instruments shall be mounted on the remote control cabinet:

For control of valves

1) Source voltmeter,

2) Source pilot light

3) Load ammeter,

4) Position indicators for all discharge valves,

5) Indicating lights and push button switches for valves in quantities for discharge valves and guard valves for water supply facilities and river outlet facilities as tabulated below.

Particular	Water Supply Discharge Valve	Water Supply Guard Valve	River Outlet Discharge Valve	River Outlet Guard Valve	Color
Indicating lights					
a) Fully closed	1	1	1	1	Green
b) Fully opened	1	1	1	1	Red
c) Opening	1	1	1	1	Red
d) Closing	1	1	1	1	Green
e) Trouble	1	1	1	1	Amber
f) Valve locked	Nil	1	Nil	1	Red
g) Pressure balanced	1		1		Green
Push button switches					
a) "Open"	1	1	1	1	
b) "Close"	1	1	1	1	
c) "Stop"	1	1	1	1	
d) "Lamp test"	1				

6) All other necessary relays contactors, switches and miscellaneous components.

For oil pressure unit

1) Load ammeter,

2) Indicating lights and push button switches for oil pressure unit are as tabulated below.

Indicating lights

a) Main pump operating,
b) Standby pump operating,
c) Normal pressure,
d) Low pressure, and
e) Trouble

3) All other necessary relays, contactors, switches and miscellaneous components.

Indicating lights for "Opening", "Closing", "Low pressure", and "Trouble" shall be capable of flickering during lighting.

(3) Electric valve position transmitters and indicators

Two (2) pairs of the electric valve position indicators with their transmitters shall be provided for the control of the discharge valves. The remote indicators shall be mounted on the local and remote control cabinets of the valves. The local indicators with their transmitters shall be house in the complete weather proof enclosure.

T7.17.3 Oil pressure unit details

(1) General

The oil pressure unit details shall consist of two (2) sets of oil pumps with motors, an oil supply tank, four-way valves, relief valves, flow control valves, oil filters,pressure switches, flexible conduit, hydraulic oil and other necessary components.

The discharge and guard valves shall be operated separately by a common use oil pressure unit. The oil unit shall have sufficient capacity to operate a discharge valve or a guard valve for river outlet facilities, whichever greater.

The oil unit shall be arranged and be installed to fit in the space of the valve chamber. All articles of commercial products, such as motor, oil pump, hand pump, switches, valves, gauges, and other equipment which is incorporated as manufactured goods in the controls, shall be of high quality equipment, suitable for the function that is required to perform the operation of these valves. The oil pressure unit shall be capable of resisting the inner pressure more than 70 kilograms per square centimeter for which the relief valve be set. The details of construction of the oil pressure unit not specified herein will be left to the Contractor, subject to approval by the PMO/Engineer.

(2) Motor

The oil pump motor shall be a horizontal, weatherproof, squirrel cage type, having normal starting torque and low starting current characteristics and shall be suitable for direct-on-

line starting, direct drive, non-reversing service. The electrical insulation shall be moisture-resistant type which will insure satisfactory operation of the motor in a humid atmosphere.

(3) Oil pumps

The oil pumps shall be of the rotary type. The pumps shall be suitable for pumping a light hydraulic oil. The pump shafts having suitable bearings shall be adequately packed or sealed to prevent leakage, and shall be suitable for direct connection to the pump motor with flexible couplings. The pumps shall be equipped with steel flanges suitable for threading or socket-welding to suction pipe and welding only to discharge pipe.

(4) Four-way valve

The four-way valves shall be suitable for use with light hydraulic oil having the characteristics specified for the oil pumps. The valve shall have steel socket-welding flanges. The porting and operation of the valves shall be arranged so that pressure can be directed to either of two outlet ports as read on the indicator.

(5) Relief valves

The relief valves shall be suitable for use with light hydraulic oil having the characteristics specified for the oil pumps and for incorporation into the piping assembly.

(6) Flow control valves

The flow control valves shall be controlled flow in one direction and integral check valve to allow free flow in the opposite direction. The valve shall have steel socket welding flanges and shall be suitable for incorporation into the piping assembly.

(7) Oil filters

The oil filters shall be of the removable filter-unit type. The filter shall be suitable for use with light hydraulic oil having the characteristic specified for the oil pump and for incorporation into the piping assembly.

(8) Pressure switches

The pressure switches shall have independent outside adjustments with a locking device for setting the cut-in and cut-out pressures, and the pressure setting shall show on a calibrated dial.

(9) Flexible couplings

The flexible couplings shall be of all metal type suitable for accommodating radial and angular misalignment. The coupling shall be of adequate capacity to drive the pump and shall be accurately bred and key seated to fit the motor and pump shaft.

(10) Oil supply tank

The oil supply tanks shall be of welded construction and be provided with a hand pump, an oil level gauge, an oil inlet, an oil drain outlet and legs. The tank shall have sufficient capacity for the total quantity of oil required for all valves.

(11) Hydraulic oil

The hydraulic oil to be used in the operation system shall be capable of working efficiency over the temperature 0 ^{0}C to 60 ^{0}C.

The hydraulic oil shall have good stability, anti-floating, antioxidant, anti-corrosion and anti-wear properties. Sludges and slurries shall not be formed under any working conditions.

The hydraulic oil shall be of a reputable manufacturer for adequate to the system designed, and the characteristics and properties of hydraulic oil shall be submitted to the PMO/Engineer for approval.

T7.17.4 Wiring

The wiring between the electrical terminal point and the electrical equipment to be furnished with the hydraulic hoist for valves and air valves shall conform to the requirements of Clause T7.5 "Electrical Equipment and Parts".

T7.17.5 Piping

The piping between the oil pressure unit and the hydraulic hoists shall conform to the requirements of Clause T7.4 "Mechanical and Structural Works".

Necessary stop valves shall be provided by the Contractor for maintenance and repairing work by the Employer.

T7.17.6 Shop assembly and test

The control cabinet and oil pressure unit shall be assembled in the shop in the approximate position that they will have after installation at the site.

All pipes and fittings shall be thoroughly cleaned by washing with a solvent or wire-brushing where applicable, to remove all dirt, rust, chips, burrs, or scale from the inside surface. Care shall be taken to keep any foreign matter from entering the oil piping and oil pressure chamber during or after shop fabrication of the oil pressure unit and valves and shall be taken in the threading and welding of pipe connections to insure oil tight joints.

The oil pressure test of the oil pressure unit including all hydraulic pipings shall be made to demonstrate sufficient strength of the oil pressure unit under an oil pressure equivalent to 2.0 times the maximum design pressure and oil temperature not less that 20 ^{0}C. This condition shall be held for more than 10 minutes. All parts shall be carefully checked for leakage and any oil leakage discovered shall be repaired.

The following items, at least, shall be checked during the shop inspection and tests:

a) Operation speed ,

b) Voltage and current of electric motor,

c) Oil pressure in oil pressure unit,

d) Temperature rise of bearing, motor and oil pump,

e) Existence of noise and vibration,

f) Measurement of oil leakage past piston,

g) Accuracy of position indicator,

h) Manual operation of oil pump equipment, and

i) Condition of control cabinet.

j) Insulation resistance test on all side installed wiring and electrical connections.

Any defect or improper operation discovered during the test shall be promptly corrected and entire test shall be repeated to the satisfaction of the Employer and/or the PMO/Engineer.

T7.17.7 Installation at site

The oil pressure unit with pipings shall be assembled and erected in accordance with the FOR WORK DRAWINGS, approved installation manual and the instructions of the PMO/Engineer.

T7.17.8 Tests on completion

After completion of the entire project works, commissioning tests under both dry and watery conditions shall be performed completely by the Contractor at his costs and expenses in accordance with the approved test procedures.

The test shall consist of preliminary test and operation tests.

(1) Preliminary tests

The preliminary tests shall include but shall not confined to:

a) Inspection by feeler gauge measurement of satisfactory sealing of all seals,

b) Radiographic or ultrasonic examination of any site welds in load carrying members, other than seal welds,

c) Insulation resistance test on all side installed wiring and electrical connections,

d) Setting of limit and pressure switches, indicators and control equipment, and

e) Inspection of 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 operating pressure of hydraulic system,

c) Check of limit of travel,

d) Check of power consumption of electric motor,

e) Check of accuracy if indication and limit setting,

f) Check of water leakage from closed valve,
(a remarkable leakage shall be repaired at once),

g) Check of manual operation of oil pressure unit, and

h) Check of general satisfactory operation,

T7.18 Detailed Specifications of River Outlet Inlet Bulkhead Gate

T7.18.1 General

One (1) set of horizontally moving, slide type inlet bulkhead gate with its guide frame, and appurtenant parts complete with necessary accessories shall be designed, supplied and installed at the inlet portion of the diversion tunnel by the Contractor under this chapter of the Contract. The inlet gate shall be used for opening the river outlet inlet for supplying water to the river outlet facilities after completion of construction of the facilities.

This gate will be kept opened after completion of the Project.

The general data for the design of the inlet gate are given in sub-clause T7.18.3 "Design data" herein and these data shall be fixed and may not be altered.

The arrangement of the gate shall be as shown on the Drawings.

T7.18.2 Design stresses

The design stresses are applied 1.5 times of the allowable stresses as specified in Clause T7.13 "Design Conditions".

T.7.18.3 Design data

The inlet bulkhead gate shall be designed for the following conditions:

(1) General data

Type of gate	:	Steel made slide gate
Quantity	:	One set
Clear opening of gate	:	1,500 mm x 1,500 mm
Design head	:	51.80 m
Elevation of sealing frame	:	137.20 m
Operation head	:	51.80 m

Water filling device	:	Bypass valve
Corrosion allowance	:	Not considered
Water seal of gate	:	4 edges rubber seal at downstream face of gate
Maximum hoisting travel	:	1.60 m
Type of hoist	:	Temporary winch

(2) Design loads

(a) Gates

(i) Normal load conditions

Hydrostatic load

Head water at elevation 189.00 meters.

Tail water below sealing frame.

Self weight of the gate

Operating load of hoist

(ii) Overload conditions

Inertia force during earthquake

All loads imposed by the hoist in gate jammed condition during raising operation.

(b) Guide frames

The loading on the guide frame shall be the loads from bearing plate and all other loads due to the most adverse operation of the gate and hoist. The guide frames and anchors shall be capable of transferring the loads of the bearing plates, rubber seals and side shoes of the gate to the concrete structure.

T7.18.4 Gates details

The gate shall consist of skin plates, main beams, bearing plates, seals, side shoes, a water filling device, bottom cover plate and all other necessary components. The gate shall be of slide type and of all welded construction.

All seals shall be of the caisson type or other approved shape, activated by the upstream water pressure.

The bottom cover plate shall be provided on the bottom of gate leaf and to close the gate slot at fully opened position of the gate to protect the waterway from entering sand and foreign materials sedimented in the reservoir.

The gates shall be accurately fabricated within the following tolerances:

Portion to be measured	Tolerances (mm)
Gate width	± 5
Gate height	± 5
Gate depth	± 3
Diagonal length difference	± 5
Distance between bearing plates	± 5
Distance between side shoes	± 5
Distance between rubber seals	+ 10, -6
Distance between downstream face of bearing plate and surface of side rubber seals	+ 2, 0

The tolerances not specified herein shall be determined by the Contractor and subject to the PMO/Engineer's approval.

The other requirements for the gate details shall be in accordance with those specified in paragraph T7.14.4 "Gate details" for the intake gates and hoists.

T7.18.5 Guide frames details

The guide frames shall consist of the sealing frames, track frames, side guide frames and all other components necessary for the complete and satisfactory installation of the guide frame.

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

Points to be measured	Tolerance (mm)
Clear span	± 5
Clear height	± 5
Diagonal length difference	± 5
Distance center to center of track frames	± 5
Length of guide frame	± 5
Distance between guide frames	+ 8, 0
Flatness of sealing frames	± 0.5/m
Straightness of sealing frames	± 2
Flatness of track frame surface	± 0.5/m
Straightness of track frame surface	± 1
Straightness of side guide frames	± 2

The tolerances not specified herein shall be determined by the Contractor, subject to the PMO/Engineer's approval.

The other requirements for the gate details shall be in accordance with those specified in paragraph T7.14.4 "Gate details" for the intake gates and hoists.

T7.18.6 Shop assembly and test

The requirements for the shop assembly and tests shall be in accordance with those specified in sub-clause T7.14.8 "Shop assembly and tests" for the intake gates and hoists.

T7.18.7 Installation and tests at site

The requirements for the installation and tests at site shall be in accordance with those specified in sub-clause T7.14.9 "Installation and tests at site" for the intake gates and hoists.

The Contractor shall provided temporary hoisting equipment to open the bulkhead gate after completion of construction of the river outlet facilities with other necessary equipment.

The hoisting facilities have been planned as shown herein and on the Drawings.

The bulkhead gate will be operated by a winch to be provided by the Contractor which will locate in the space adjacent to the gate control house. Wire rope on the winch will be connected to the gate through hoisting sheaves which will be installed on the launching slope beside the intake gates. Prior to the opening operation of the gate, the water filling device shall be opened by the winch to equalize water pressure at both sides of the gate. Subsequently, the gate shall be opened fully by the winch. The winch shall be removed after completion of operation of the gate. The wire ropes and sheaves shall be kept in the reservoir and these apparatus shall be removed during low water period of the reservoir.

The Contractor shall propose his own idea on the operation of the gate and removal of these apparatus based on the above procedure.

T7.18.8 Tests on completion

The requirements for the tests on completion shall be in accordance with those specified in sub-clause T7.14.10 "Tests on completion" for the intake gates and hoists.

T7.19 Detailed Specifications of River Outlet Trash Racks

T7.19.1 General

One (1) set of cage type fixed trash racks shall be designed, supplied and installed at the entrance of inlet of the river outlet conduits by the Contractor under this chapter of the Contract. The trash

racks shall be designed to prevent the entrance of matters injurious to the river outlet discharge and guard valves, and to withstand adequately the static and other loads, and to avoid vibration phenomena which are likely to occur due to flow of water passing through the trash racks.

The general data for the design of the trash racks are given in sub-clause T7.19.3 "Design data" herein and these data shall be fixed and may not be altered.

The arrangement of trash racks shall be as shown on the Drawings.

T7.19.2 Design stresses

The design stresses shall conform to those specified in Clause T7.13 "Design Conditions".

T7.19.3 Design data

The cage type trash racks shall be designed for the following conditions:

(1) General data

Type : Fixed type

		Top trash rack	Side trash racks
Quantity	:	One (1) set	Four (4) sets
Clear span	:	2.60 m	2.60 m
Width/height	:	2.60 m (Width)	2.50 m (Height)

Bar pitch : 100 mm (center to center)

Design head : A water head difference of 2.00 m at normal load

(2) Design loads

(a) Trash rack panels

Design head difference of 2.00 m at normal and load.

Operation load

Dead weight of trash rack panels

(b) Supporting frames

The following loads shall be considered:

(i) The reaction load due to water load on the bar element.

(ii) The load due to its own weight.

T7.19.4 Trash racks details

The trash racks shall consist of bar elements, steel frames, supporting beams and all other necessary components. The trash rack panel shall be fixed on the steel frames using corrosion-resisting bolts, nuts and washers.

The steel frames shall be of JIS G 3466 (STKR) of the carbon steel square pipes for general structure purposes or JIS G 3454 (STP) of the carbon steel pipes for pressure service. Bottom parts of the frame shall be embedded in the concrete structure. Thickness of the above square pipes shall not be less than 8.0 millimeters.

The details of construction of trash racks, not specified herein, shall be made by the Contractor upon approval of the PMO/Engineer.

The trash rack panels shall be accurately fabricated and installed in accordance with the "FOR WORK DRAWINGS" within the following tolerances:

Points to be measured	Tolerance (mm)
Panel width	± 5
Panel height	± 5
Diagonal length	± 5
Bar pitch	± 3
Straightness of bar elements	± 1/m
Lateral flatness of screen face	± 2/m

The tolerances not specified herein shall be determined by the Contractor, subject to the PMO/Engineer's approval.

The other requirements for the river outlet trash racks shall be in accordance with those specified in sub-clause T7.15.4 "Trash racks details" for the intake trash racks.

T7.19.5 Shop assembly and tests

The requirements for the shop assembly and tests shall be in accordance with those specified in sub-clause T7.15.5 "Shop assembly and tests" for the intake trash racks.

T7.19.6 Installation and tests at site

The requirements for the installation and tests at site shall be in accordance with those specified in sub-clause T7.15.6 "Installation and tests at site" for the intake trash racks.

T7.19.7 Tests on completion

The requirements for the tests on completion shall be in accordance with those specified in sub-clause T7.15.7 "Tests on completion" for the intake trash racks.

T7.20 Detailed Specifications of River Outlet Facilities

T7.20.1 General

One complete set of the river outlet facilities consisting of the steel conduits, a discharge valve and a guard valve shall be designed, supplied and installed in the diversion tunnel in parallel with the water supply facilities.

The river outlet facilities shall be used to discharge water to the downstream of the dam through the discharge valve for emergency water discharge for safety of stability of the dam.

The steel conduit shall consist of straight pipes, a reducing pipe, bell mouth, seepage rings, stiffeners, thrust rings, drain system with all necessary components.

The discharge valve consisting of a hollow jet valve, oil pressure piping and controls with all necessary components shall be designed, supplied and installed at the downstream end of the river outlet steel conduit in the valve chamber in the diversion tunnel.

The guard valve consisting of a circular section high pressure gate valve, hydraulic servomotor, oil pressure piping and controls with all necessary components shall be designed, supplied and installed in the valve chamber in the diversion tunnel. The guard valve shall be provided in front of the discharge valve to shut off the water flow when the discharge valve is not in service or is required for inspection and maintenance. The valve shall be at either fully opened or fully closed positions and operated under subsequently balanced condition, but shall be capable of shutting off water flow at any water head when the discharge valve cannot be closed.

These valves shall be operated and controlled by control cabinet to be specified in Clause T7.17 "Detailed Specifications of Operation and Control"

The Contractor shall exercise special care in the design of the conduit and valves to avoid vibration during the operation of the facilities under any opening of the valve and leakage under fully closed condition. The general data for the design of the conduit and valves are given in sub-clause T7.20.3 "Design data" and these data shall not be altered. The arrangement of the conduit shall be as shown on the Drawings.

T7.20.2 Design stresses

The design stresses shall conform to those specified in Clause T7.13 "Design Conditions".

T7.20.3 Design data

(1) Steel conduit

Type of conduit	:	Embedded steel conduit
Quantities to be provided		
Steel conduit	:	1 lane
Drain system	:	1 set
Diameter of conduit	:	1,500 to 1,000 mm

Length of conduit	:	
in plug Nos. 1 and 2	:	24.30 m
in main plug	:	37.00 m
Diameter of drain system		
for steel conduit of 1,500 mm	:	200 mm (nominal)
for steel conduit of 1,000 mm and guard valve	:	50 mm (nominal)
Diameter of manhole	:	600 mm
Internal design head	:	80.00 m
External design head	:	80.00 m
Grout pressure	:	2.5 kgf/cm^2
Corrosion Allowance	:	2.0 mm for all components exposed in water
Welding efficiency	:	95% at shop and 90 % at site weld

(2) Discharge valve

Type of valve	:	Hydraulically operated hollow jet valve
Quantities to be provided	:	1 set
Diameter of valve	:	1,000 mm
Design head	:	80.00 m
Valve center elevation	:	EL. 129.016 m
Water seal of valve	:	Metallic seal on plunger and valve body
Type of hoist	:	Hydraulic servomotor
Operation head	:	80.00 meters
Operation speed	:	0.1 m/min. ± 10%
Maximum discharge	:	25 m^3/s at 80.00 m head
Discharge coefficient	:	0.8 or more at fully opened
Operation method	:	Local control in valve chamber of diversion tunnel and remote control from the dam control house

(3) Guard valve

Type of valve	:	Hydraulically operated high pressure gate valve
Quantity	:	One (1) set
Diameter	:	1,000 mm
Design head	:	80.00 m
Valve center elevation	:	EL. 129.016 m
Water seal of valve	:	Metal touch seat
Type of hoist	:	Hydraulic servomotor
Operating head		
Normal	:	Under balanced water head condition
Emergency	:	80.00 m
Operating speed	:	0.1 m/min. ± 10%
Operation method	:	Local control in valve chamber of diversion tunnel and remote control from dam control house
Diameter of bypass system	:	100 mm (nominal)

In addition to the above, the erection load due to its own weight, all loads imposed during starting, opening or closing the valve shall be considered on the design of each valve.

The other requirements for the river outlet facilities shall be in accordance with those specified in sub-clause T7.16.3 "Design data" for the water supply facilities.

T7.20.4 Steel conduit details

The steel conduit shall be of circular section and consist of steel conduits, reducing pipe, bell mouth, seepage rings, stiffener rings, grout holes and plugs, manhole, manhole cover, dismantling joint at downstream side of guard valve, and other necessary components for proper operation, maintenance and services.

The reducing pipe having internal diameter of 1,500 millimeters and 1,000 millimeters shall be provided in the valve chamber.

Manhole shall be provided on the conduit between the guard and discharge valves.

The other requirements for the steel conduit shall be in accordance with those specified in sub-clause T7.16.4 "Steel conduit details" for the water supply facilities.

The drain system shall consist of drain valves and drain pipes to discharge trapped water in the steel conduit and bottom of the guard valve.

The drain system for the steel conduit of 1,000 millimeters in diameter and the guard valve shall consist of steel pipes and serially connected valves having nominal diameter of 50 millimeters.

T7.20.5 Fabrication of steel conduits

The requirements for the shop assembly and tests shall be in accordance with those specified in sub-clause T7.16.5 "Fabrication of steel conduits" for the water supply steel conduit.

T7.20.6 Discharge valve details

The requirements for the discharge valve shall be in accordance with those specified in sub-clause T7.16.6 "Discharge valve details" for the water supply facilities.

T7.20.7 Guard valve details

The requirements for the guard valve shall be in accordance with those specified in sub-clause T7.16.7 "Guard valve details" for the water supply facilities.

T7.20.8 Tests and inspections for conduit

The requirements for the tests and inspections for conduit shall be in accordance with those specified in sub-clause T7.16.8 "Tests and inspections for conduit" for the water supply facilities.

T7.20.9 Shop assembly and test for valves

The requirements for the shop assembly and tests shall be in accordance with those specified in sub-clause T7.16.9 "Shop assembly and tests for valves" for the water supply facilities.

T7.20.10 Installation and tests at site

The requirements for the installation and tests at site shall be in accordance with those specified in sub-clause T7.16.10 "Installation at site" for the water supply facilities.

T7.20.11 Tests on completion

The requirements for the tests on completion shall be in accordance with those specified in sub-clause T7.16.11 "Tests on completion" for the water supply steel conduit.