CONSTRUCTION OF THE JATIBARANG MULTIPURPOSE DAM

PACKAGE 1: JATIBARANG MULTIPURPOSE DAM INCLUDING APPURTENANT STRUCTURES

SPECIFICATION

SECTION 12. WATER CONTROL PLANT

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SECTION 12. WATER CONTROL PLANT

12.1 REQUIREMENT

12.1.1 General

a. The work covered by this Section of the Specification shall include the design, manufacture, factory testing, supply, delivery to site, erection, site testing and commissioning of the Water Control Plant for the Outlet Works and Diversion Works.

b. The Contractor shall sublet the design, manufacture, erection, testing and commissioning of all Water Control Plant to a specialist Subcontractor or Subcontractors who have experience in works of similar nature to those covered by this Section of the Technical Specification. The Subcontractor(s) shall be as proposed by the Contractor in his Tender and approved in the Letter of Acceptance.

12.1.2 Scope of Works

The Water Control Plant comprises

a. For Outlet Works

(i) One complete set of trash racks for intake structure;

(ii) One complete set of trash racks for emergency gate;

(iii) One complete set of trash rack for inspection room;

(iv) One complete set of bulkhead gate unit for intake structure;

(v) One complete set of emergency gate unit for intake structure;

(vi) One complete set of steel conduit consisting of inlet pipe including bellmouth, transition and connecting pipe and outlet pipe including bifurcation and reducer;

(vii) One complete set of guard gate unit for emergency outlet structure;

(viii) One complete set of control gate unit for emergency outlet structure;

(ix) One complete set of guard gate unit for maintenance outlet structure;

(x) One complete set of control gate unit for maintenance outlet structure;

(xi) Appurtenance such as air vents, air valve, filling and draining device, supersonic flow meter and any other parts specified in this section of the Specification.

b. For Diversion Works

One complete set of diversion gate structure diversion works;

c. Supplementary Equipment

This Section also includes designing, furnishing, delivering and installing the following supplementary materials and equipment:

(i) Erection supplies such an supports, stands, stays for erection use and other parts such as bolts, nuts, screws, washers, to be placed and/or removed during field installation, electrodes, grouting or filling material, electric cables and conduits.

(ii) All mechanical fluid, grease and lubricating oil required for initial filling, testing, commissioning and operation.

(iii) All paint required for painting.

(iv) Maintenance tools such as a complete set of maintenance tools needed for the lubrication, adjustment and normal maintenance of each unit and part of the Water Control Plant. These tools shall be neatly mounted in heavy duty steel tool box(es) provided with locks.

(v) Maintenance equipment such as a complete set of special devices required for dismantling and removing any part of the Water Control Plant.

(vi) Spare parts such as all basic spare parts which are listed for each group of Water Control Plant items.

(vii) Labels and plates for each item of Water Control Plant. Unless otherwise required by the Employer or the Engineer, all duty labels, instruction plates and name plates on equipment shall be in English.

d. All other incidentals not specifically stated.

e. Unless otherwise specified, the contractor shall supply and perform all works and temporary work described herein or required carry out the work.

12.1.3 Drawing Furnished by the Employer

a. The details shown on the Drawing for the gates, trash racks, steel conduit and Pipe work are indicative only and show the general layout of the Water Control Plant. Only limiting or mandatory dimensions and elevations are shown on the Drawings.

b. The Contractor shall provide full details, designs, drawings, schedules and data for the Water Control Plant in accordance with the requirements of this Clause. Changes to limiting or mandatory dimensions shall be subjected to approval by the Engineer.

12.2 DEFINITION OF TERMS

Whenever used in connection with the Contract, the under-mentioned terms shall have the following meaning assigned to them.

a. "Gate unit" or "gate" means a complete set of parts that are required and are sufficient to close one water passage. A gate unit will include a gate leaf and guide frames, bonnet and hoist as applicable.

b. "Gate leaf" means a part of a gate unit serving to close one water passage.

c. "Gate frame" means the part of a gate unit which is to be embedded in or attached to the civil works such as track rails, track plates, seal plates, bearing plates, sill beams, lintel beams and cover plates.

d. "Embedded parts" means all anchor bolts, anchor bars and anchor beams embedded in the concrete in order to install the gate structures or other equipment.

e. "Hoist" means a device serving to move, open and close, a gate leaf including all related equipment necessary for the indication of the gate position and other similar functions.

f. "Control cabinet" means the unit containing electric equipment and components for the control of one or more hoists.

g. "Control panel" means a part of the control cabinet, a steel panel on which all control devices and instruments require for the operation of the hoist is mounted.

12.3 DRAWINGS AND INFORMATION TO BE PROVIDED BY THE CONTRACTOR

12.3.1 General

The Contractor shall prepare and be fully responsible for the correctness of all design and drawings which are necessary for the design, manufacture, supply, delivery, erection, commissioning and storage of the Water Control Plant.

12.3.2 Fabrication and Installation Programme

The Contractor shall prepare and submit a Fabrication and Installation Programme for the Water Control Plant in critical path method (CPM) or PERT time form with sufficient detail to define sections of the work covering the design, approval, manufacture, delivery, erection, testing and commissioning and inspection of all stage for the work. The programme shall be a sub-section of the overall construction programme specified in Sub-Clause 1.5.2.

12.3.3 Holes and Block-outs for Embedded Frames and Pipes

At an early stage the Contractor shall determine his requirements for the sizes of holes and block-outs for embedded frame and pipes in the walls and slabs for each structure and submit the details for approval. On receipt of approval from the Engineer the holes and block-outs shall be provided in the concrete structures along with all necessary anchor bolts and parts to be embedded in the first stage structural concrete.

12.3.4 Submission of Drawings and Information

a. The Contractor shall submit shop drawing showing the dimensions, details and materials to be used for fabrication in accordance with the requirements of Sub-Clauses 1.4 and 1.5. The Engineer will review and approve the shop drawings in accordance with the procedures described in Sub-Clause 1.4.

b. Copies of the approved drawings shall be furnished to the Engineer. Approval of the drawings shall not relieve the Contractor of meeting the requirements of the Contract.

c. The Engineer shall have the right to require the Contractor to make any change in the design which may be necessary to ensure that the works

conform to the requirements of the Contract without additional cost to the Employer.

d. After the Water Control Plant has been manufactured and erected the Contractor shall submit "As-built" Drawings to the Engineer in accordance with Sub-Clause 1.4.

12.3.5 Reporting

The Contractor shall report in accordance with Clause 1.5.

12.3.6 Instructions for Erection Work

a. The Contractor shall submit to the Engineer for approval five (5) months before proceeding with the erection of any part of the works, the instruction manual for the erection and installation to be executed at the Site.

b. The erection manual shall be submitted for approval in the same manner as the shop drawing and, when approved, the Contractor shall submit ten (10) copies to the Engineer.

c. The Contractor shall employ a specialist erection supervisor for this work. The Contractor shall ensure that a copy of the approved erection manual is held in his office at the Site at all time.

d. The Contractor shall employ a specialist painting supervisor from the paint supplier to supervise all painting work in the shop and field.

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

12.3.7 Operation and Maintenance Instructions

a. The Contractor shall submit to the Engineer the detailed instructions concerning operation and maintenance of all equipment provide for the Water Control Plant under this section of the Specification with special references to any recently developed features.

b. The operation and maintenance (O & M) manual shall be prepared for each gate unit and shall be submitted for approval 5 months before completion of the work in the same manner as the drawing in accordance with Clause 1.4. When approved ten (10) complete sets of O & M manual, prepared on high quality reproducible paper from which clear copies can be made, shall be furnished to the Engineer for transmittal to the Employer. Five (5) sets of the O & M manual shall be hard bound and the remaining five (5) sets shall be bound in loose leaf format, all to the Engineer's approval. The Contractor shall ensure that a copy is available in his office at the Site.

c. The O & M manual shall include separable and complete sections describing the normal and emergency operating procedures for the control of the equipment, and shall include easily read diagrammatic drawings of the equipment to facilitate understanding the descriptive information.

d. The O & M manual shall describe and illustrate in detail the method and procedures for assembling, adjusting, operating and dismantling of each component, system and machine and the use of tools and device necessary for such works. The maintenance of each component shall be described, including the recommended frequency of inspection and lubrication.

e. The Contractor shall, in preparing the O & M manual, take into account the lack of experience and familiarity of the operating personal with this type of equipment.

f. The O & M manual shall include a complete list of all drawings prepared for this Contract, the spare parts list, and parts list for each component of item of equipment and necessary catalogues. The parts list shall include manufacturer's code and serial numbers and ordering instructions. The parts list shall be detailed for the equipment supplied and shall not be only a general reference nor description of similar equipment nor of the same model but different in detail.

12.3.8 Unit of Measurement

The metric system of measurement shall be employed in all correspondence, technical schedules and drawings. On drawings or printed pamphlets where another system of measurement has been used, the equivalent metric measurement shall be provided.

12.3.9 Language

English shall be used in all drawings, design data, catalogues, cuts, illustrations, printed specifications, instructions, O & M manuals and parts lists submitted.

12.3.10 Instruction to Employer's Staff

During and after erection of the various items of plant, the Contractor shall instruct those employees designated by the Employer who will subsequently be responsible for the adjustment, operation and maintenance of the plant. The O & M manual as specified in Sub-Clause 12.3.7 of this Clause shall be explained in detail and each trainee shall have practised the operation, inspection and maintenance of plant. The course of instruction shall be carried out to the satisfaction of the Engineer and Employer, and shall be given in English or Indonesian language, for which an interpreter will be provided by the Employer, if required. This instruction shall continue until thirty (30) days after the date of issue of the Certificate of Completion of the whole of the Works.

12.4 STANDARDS

a. The work shall be carried out in accordance with the standards specified in Clause 1.6.

b. Where a standard is not specified, the Engineer will nominate the standard to be used. Generally the standards for use in the works shall be:

(i) For Materials:

Japanese Industrial Standards (JIS)

(ii) For Structures:

Gates, Valves and Steel Conduits:

Japan Hydraulic Gate and Penstock Association Technical Standards for Gate and Penstock and Technical Standards for Gate Facilities of Dams and Weirs

(iii) For Electrical Equipment:

Standard of the Japanese Electro - Technical Committee's Standards (JEC)

Japanese Engineering Standards (JES)

The Standards of the Japan Electrical Manufacturer's Association (JEM)

Japanese Cable-Markers Association Standards (JCS)

International Electrotechnical Commission(IEC)

c. The used of alternative standards and specifications of other countries and recommendations of international standards organisations will be accepted provided that they are substantially equivalent to the designated standards and provided further that the Contractor submits, for approval, copies of the standards and specifications proposed for use.

12.5 TRASH RACK FOR THE INTAKE STRUCTURE OF OUTLET WORKS

12.5.1 General

a. This Clause specifies the detailed technical requirements for the design and manufacture of the trash rack for the intake structure of outlet works to be furnished in accordance with this section of the Specification. These requirements supplement and/or modify the applicable requirements in other relevant Clauses in this Section of the Specification.

b. The trash rack for the intake structure shall be installed between EL.152.200 and EL.130.000 as shown on the Drawings.

c. The trash rack shall consist of bar elements, binding bolts, distance piece, supporting beams, cover plates, gate guide for the emergency gate and other necessary components. Trash rack panels, which are composed of suitable number of bar elements bound by corrosion-resistant bolts and nuts, shall be bolt-connected to supporting beams. The binding bolts and nuts shall be of corrosion-resistant steel.

12.5.2 Design Conditions

a. General Data

Type of Trash Rack	: Steel fixed trash rack
Elevations	
Top of Trash Rack	: EL.152.200
Bottom of Trash Rack	: EL.130.000
Breadth	: 2.000 m
Inclination angle	: 1 vertical to 1.4 horizontal

Bar element

Bar shape	: Rectangular
Thickness	: 12 mm (including corrosion allowance)
Breath	: 65 mm (including corrosion allowance)
Clear spacing between bars	: 88 mm (including corrosion allowance)
Design pressure	: 0.2 kgf/cm^2
Corrosion allowance	: 1.0 mm (One face)
Allowable Stress	
For Steel	: Tension, Compression 0.5y
	as a basic shear 0.5y / 3
For Bar Element	: 0.6 y (1.23 - 0.0153 L / t)
	Where
	y: Yield stress of material kgf/cm^2
	L: Binding bold pitch cm
	t : Thickness of bar element cm
For Concrete	: Bearing 60 kgf/cm^2
	Shearing 4.0 kgf/cm^2
	Bond 7.0 kgf/cm^2

b. Flow-Induce Vibration

(i) The Contractor shall design the trash rack panels and their individual member for static safety.

(ii) The Contractor shall also design the trash rack panels to prevent vibration induced by the flow through the trash rack.

(iii) Flow velocity used for calculation shall be 1.5 m/s ; Strouhal number of bar elements shall be 0.2.

(iv) The natural frequency of bar elements taking the additional mass effect into account shall be at least 2.5 times the vortex shedding frequency of flow.

c. Bar Elements

The bar elements of the trash rack panel shall be of rectangular section bars. All bar elements shall be transversely connected with binding bolts and nuts, washers and spacing pieces. All bar elements framed into panels shall be rigidly fixed on the supporting beams to prevent flow induced vibration, etc.

d. Spacing pieces

Spacing pieces shall be arranged to keep the clear spacing between adjacent bar elements as specified. Spacing pieces shall be of steel pipes through which the binding bolts can pass.

e. Supporting beams

The supporting beams shall be of H-beam, built-up and/or angle type steel construction and all or both ends of the beams shall be embedded in the concrete structure with gate guide for the Emergency Gate. The ends of the supporting frames shall be attached to anchor bolts or beams which shall be embedded in second stage concrete. Anchor bars shall be provided in first stage concrete around the block-out or recess for erection.

f. Trash rack panels

(i) Where the bottom edge of a trash rack panel shall rest on a supporting beam, the supporting beam shall include a rest support to take the inclined load of the trash rack panel such that each trash rack panel is readily capable of being removed and installed without the need to support or disturb any adjacent panels.

(ii) The Trash rack panels shall be firmly fastened to the supporting beams using J-shaped corrosion resistant bolts and nuts to hook around the spacing pieces. The bolts shall be of sufficient size and at suitable spacing at securely anchor the trash rack panels against vibration. Lock-nuts shall be used on each bolt by the use of double nuts.

12.6 TRASH RACK FOR THE EMERGENCY GATE OF OUTLET WORKS

12.6.1 General

a. This Clause specifies the detailed technical requirements for the design and manufacture of the trash rack for the emergency gate of the outlet works to be furnished in accordance with this section of the Specification. These requirements supplement and/or modify the applicable requirements in other relevant Clauses in this Section of the Specification.

b. The trash rack for the emergency gate shall be installed between EL.116.476 and EL.115.000 as shown on the Drawings.

c. The trash rack shall consist of bar elements, binding bolts, distance piece, supporting frames and other necessary components. trash rack panels, which are composed of suitable number of bar elements bound by corrosion-resistant bolts and nuts, shall be bolt-connected to supporting frames. The binding bolts and nuts shall be of corrosion-resistant steel.

12.6.2 Design Conditions

a. General Data

Type of Trash Rack	: Steel fixed trash rack
Elevations	
Top of Trash Rack	: EL.116.476
Bottom of Trash Rack	: EL.115.000
Breadth	: 3.000 m
Depth	: 0.600 m

Height	: 2.540 m
Inclination angle	: 1 vertical to 1.4 horizontal
Bar element	
Bar shape	: Rectangular
Thickness	: 9.0 mm (including corrosion allowance)
Breath	: 90.0mm (including corrosion allowance)
Clear spacing between bars	: 91.0mm (including corrosion allowance)
Design pressure	: 0.2 kgf/cm^2
Corrosion allowance	: 1.0 mm(One face)
Allowable Stress	
For Steel	: Tension, Compression 1.125y / 2 as a basic shear 1.125y / 2 / 3
For Bar Element	: 0.6 y (1.23 - 0.0153 L / t) Where y: Yield stress of material kgf/cm^2 L: Binding bold pitch cm t: Thickness of bar element cm
For Concrete	: Bearing 60 kgf/cm^2 Shearing 4.0 kgf/cm^2 Bond 7.0 kgf/cm^2

b. Flow-Induce Vibration

(i) The Contractor shall design the trash rack panels and their individual member for static safety.

(ii) The Contractor shall also design the trash rack panels to prevent vibration induced by the flow through the trash rack.

(iii) Flow velocity used for calculation shall be 1.071 m/s ; Strouhal number of bar elements shall be 0.2.

(iv) The natural frequency of bar elements taking the additional mass effect into account shall be at least 2.5 times the vortex shedding frequency of flow.

c. Bar Elements

The bar elements of the trash rack panel shall be of rectangular section bars. All bar elements shall be transversely connected with binding bolts and nuts, washers and spacing pieces. All bar elements framed into panels shall be rigidly fixed on the supporting frames to prevent flow induced vibration, etc.

d. Spacing pieces

Spacing pieces shall be arranged to keep the clear spacing between adjacent bar elements as specified. Spacing pieces shall be of steel pipes through which the binding bolts can pass.

e. Supporting frames

Supporting frames shall be provided to sustain the load and maintain the shape of the trash rack under the design load. The ends of the supporting frames shall be attached to anchor bolts or beams which shall be embedded in second stage concrete and shall be designed to transmit and disperse the design loads safely to the concrete. Anchor bolts or bars shall be provided in first stage concrete around the block-out or recess for erection.

f. Trash rack panels

(i) Where the bottom edge of a trash rack panel shall rest on a supporting beam, the supporting beam shall include a rest support to take the inclined load of the trash rack panel such that each trash rack panel is readily capable of being removed and installed without the need to support or disturb any adjacent panels.

(ii) The trash rack panels shall be firmly fastened to the supporting beams using J-shaped corrosion resistant bolts and nuts to hook around the spacing pieces. The bolts shall be of sufficient size and at suitable spacing at securely anchor the trash rack panels against vibration. Lock-nuts shall be used on each bolt by the use of double nuts.

12.7 TRASH RACK FOR THE INSPECTION ROOM OF OUTLET WORKS

12.7.1 General

a. This Clause specifies the detailed technical requirements for the design and manufacture of the trash rack for the inspection room of the outlet works to be furnished in accordance with this section of the Specification. These requirements supplement and/or modify the applicable requirements in other relevant Clauses in this Section of the Specification.

b. The trash rack for the intake structure shall be installed between EL.156.400 and EL.152.800 as shown on the Drawings.

c. The trash rack shall consist of bar elements, binding bolts, distance piece, supporting beams and other necessary components. Trash rack panels, which are composed of suitable number of bar elements bound by corrosion-resistant bolts and nuts, shall be bolt-connected to supporting beams. The binding bolts and nuts shall be of corrosion-resistant steel.

12.7.2 Design Conditions

a. General Data

Type of Trash Rack : Steel fixed trash rack

Elevations

Top of Trash Rack : EL.156.400

Bottom of Trash Rack : EL.152.800

Breadth : 4.200 m

Inclination angle : 1 vertical to 1.4 horizontal

Bar element

Bar shape	: Rectangular
Thickness	: 12 mm (including corrosion allowance)
Breath	: 65 mm (including corrosion allowance)
Clear spacing between bar	
Supporting Beams	: 88 mm (including corrosion allowance)
Beam shape	: H 150 x 150 x 7 / 10
Design pressure	: 0.2 kgf/cm^2
Corrosion allowance	: 1.0 mm(One face)
Allowable Stress	
For Steel	: Tension, Compression 0.5y
	as a basic shear 0.5y / 3
For Bar Element	: 0.6 y (1.23 - 0.0153 L / t)
	Where
	y: Yield stress of material kgf/cm^2
	L: Binding bold pitch cm
	t : Thickness of bar element cm
For Concrete	: Bearing 60 kgf/cm^2
	Shearing 4.0 kgf/cm^2
	Bond 7.0 kgf/cm^2

b. Bar Elements

The bar elements of the trash rack panel shall be of rectangular section bars. All bar elements shall be transversely connected with binding bolts and nuts, washers and spacing pieces. All bar elements framed into panels shall be rigidly fixed on the supporting beams.

c. Spacing pieces

Spacing pieces shall be arranged to keep the clear spacing between adjacent bar elements as specified. Spacing pieces shall be of steel pipes through which the binding bolts can pass.

d. Supporting beams

The supporting beams shall be of H-beam type steel construction and all or both ends of the beams shall be embedded in the concrete structure. The ends of the supporting frames shall be attached to anchor bolts or beams which shall be embedded in second stage concrete and shall be designed to transmit and disperse the design loads safely to the concrete. Anchor bars shall be provided in first stage concrete around the block-out or recess for erection.

e. Trash rack panels

(i) Where the bottom edge of a trash rack panel shall rest on a supporting beam, the supporting beam shall include a rest support to take the inclined load of the trash rack panel such that each trash rack panel is readily capable of being removed and installed without the need to support or disturb any adjacent panels.

(ii) The Trash rack panels shall be firmly fastened to the supporting beams using J-shaped corrosion resistant bolts and nuts to hook around the spacing pieces. Lock-nuts shall be used on each bolt by the use of double nuts.

12.8 BULKHEAD GATE FOR OUTLET WORKS

12.8.1 General

a. This Clause specifies the detailed technical requirements for the design and manufacture of the bulkhead gate equipment for the intake structure to be furnished in accordance with Section of the Specification. These requirements supplement and/or modify the applicable requirements of other relevant Clauses of this Section of the Specification.

b. The Bulkhead gate equipment shall include the following major items described in this Clause.

- One wheel-type bulkhead gate leaf;
- One set of guide frames;
- One set of wire rope hoist;
- One set of air pipe;
- Spare parts as listed in this Clause

12.8.2 Functions and Operations

a. Functions

(i) The bulkhead gate is used when it is necessary to maintain the conduit without lowering the reservoir water level. The bulkhead gate shall always be operated under balanced pressure conditions.

(ii) The bulkhead gate may be used during construction works of the conduit outlet pipe, guard gate and control gate while impounding the reservoir.

b. Operations

The bulkhead gate shall be operated and controlled, by operator(s), from local control panels only.

12.8.3 Design conditions

a. General Data

Type of Gate	: Steel fixed wheel gate (with 2 water filling valves)
Number of Gates	: 1 set
Design Water Level	: NWL.148.900
Wave Height	: 0.8 m
Sill Level	: EL. 113.471
Lintel Seal Elevation	: EL. 114.488
Clear span	: 2.000 m
Clear Height	: 1.40 m

Gate Height	: 2.000 m	
Operating Water Level	: Balanced pressure	
Water Seal	: Rubber seals at all sides of downstream face of gate leaf	
Type of Hoist	: Electrically driven, 1 motor, 1 drum Wire Rope Hoist	
Operating Speed	: 0.1 m/min10%	
Operation	: Local control	
Power Source	: 380V 50Hz 34W	
Rising Height	: 68.0 m more	
Seismic Intensity for Design	: k = 0.16	
Corrosion Allowance	: 0.5 mm (one face)	
Allowable Stress		
For Steel	: Tension, Compression 1.125y/2 as a basic shear 1.125y/2/3	
For Concrete	: Bearing	60.0 kgf/cm^2
	Shearing	4.0 kgf/cm^2
	Bond	7.0 kgf/cm^2

b. Hydrostatic Load

Hydrostatic Load shall be calculated from the design water level of NWL.148.900 .

12.8.4 Gate Leaf

a. Sectionalising

Gate leaf shall not be sectionalised.

b. Skin plate

The skin plate shall be on the downstream face of the gate leaf. The skin plate shall be welded to the main girders, vertical sub-beams and side beams, etc. by continuous welding.

c. Main Girders

The main girders shall be arranged in such a manner that each main girder, at the expect top and bottom girder, sustains almost the same amount of design load within a difference of ±10 %. The main girders shall be of the built-up girder and/or H-beam type steel construction.

d. Wheels

(i) An identical number of wheels shall be arranged symmetrically on both sides of the gate leaf. Each wheel shall sustain, to the extent possible, the same amount of design load.

(ii) If the number of wheels required for the design results in a statically indeterminate structure, the wheels shall be adjustable so that each wheel shall be made to contact the track plate at the

fully closed gate position. The adjustment of the wheel shaft shall be shall be designed with an offset to the wheel axis.

(iii) Wheels shall be crowned having a diameter ratio (diameter of crown in a section through the axis of the wheel to wheel diameter) of 15. The wheels shall be checked for maximum contact (Hertz's contact stress) pressures, using maximum wheel load by design loading conditions.

(iv) Wheel bearings shall be sleeve bearings with self-lubricating bushings. These bushings will require provision for a lubrication system which shall include bores, holes, slots and a lubrication fitting for a grease gun on each wheel.

e. Lifting Beam

A lifting beam shall be provided on the top of the gate leaf. The lifting beam shall be so designed that the gate leaf and the two-water-filling valves can be operated. The lifting beam shall be provided with lifting attachments for connection of wire ropes.

f. Water Filling valves

(i) The gate leaf shall be equipped with two 150mm diameter (or greater) water filling valves to fill water into the conduit and to balance the water pressure on both sides of the gate leaf before it is opened.

(ii) The water filling valves shall be operated parallel to the skin plate at an incline of 1 vertically to 1.4 horizontally and shall be slide or tappet type with rubber or metal touch water seals. A coil spring system shall be used to provide the closing force to compensate for friction effects.

(iii) The water filling valves shall be operated by operating rods connected to the lifting beam.

(iv) Two water filling valves shall be arranged symmetrically about the vertical centreline of the gate leaf and located with a centre to centre spacing of 0.750 m.

(v) The outlets of these valves shall be so arranged that the filling water jet shall not hit directly the bellmouth flare and contraction surface of the transition pipe.

(vi) The filling water shall pass screens before entering into these valves to intercept foreign matter. The clear spacing between the bars of the screen shall be not greater than 35 mm.

12.8.5 Guide Frame

a. The guide frame below EL.114.808, shall be designed in conjunction with the bellmouth entrance of the conduit and shall be continuously welded to it.

The guide frame from EL.113.471 to EL.152.800 shall be embedded in second stage concrete. Anchor bolts and/or bars shall be provided in first stage concrete around the block-out or recess for erection, alignment and restraint of the embedded guide frame.

The guide frame above EL.152.800 as measured on the datum line shall be exposed as shown on the Drawings. The support structure shall be included as part of this exposed guide frame and shall be suitably anchored to the first stage concrete to the Engineer's approval.

All sections of the guide frame shall be made continuous by approved means.

b. Sill Beam

The Contractor shall set the sill elevation of the bulkhead gate in accordance with the details shown on the drawings. The sill beam shall be designed in conjunction with the bellmouth entrance of the conduit and shall be continuously welded to it. The sill beam shall be embedded in the second stage concrete works.

c. Lintel Frame

The lintel frame shall be set at the level shown on the drawings. The lintel beam shall be designed in conjunction with the bellmouth entrance of the conduit and shall be continuously welded to it. The lintel beam shall be embedded in the second stage concrete works.

d. Seal Plate

Seal plates shall be of corrosion resistant steel. Side seal, sill seal and lintel seal plates shall be continuous to ensure water-tightness and shall be continuously attached to the bellmouth entrance of the conduit.

e. Track Plate

Track Plate shall be of corrosion resistant steel and the part where the wheel load acts shall have a hardness of at least 10 points Brinell hardness number higher than wheel treads.

12.8.6 Hoist

a. Hoisting Height

The bottom lip of the gate leaf shall be lifted up at least to EL. 152.800.

b. Rope Slack and Overload Detector

The hoist shall be provide with a rope slack detector and overload detector. The rope slack detector shall be established in a hoist frame and near a part of wire rolling drum. The overload detector may detect by over current. When these detectors are functioning the motor shall be electrically disengaged.

c. Resting Device

(i) The hoist shall be provided with a gate leaf resting device which shall be operated manually. The resting device shall enable the gate leaf to rest at the position with the bottom of the gate leaf being above EL.152.800.

(ii) The resting device shall be attached to the hoist base frame or exposed guide frame above EL.152.800.

d. Wire rope

Wire rope shall be to JIS G 3525 6 x 37, A-type wire rope or equivalent and shall be galvanised.

e. Wire Hole Guides

(i) Roller type wire rope guides shall be furnished and anchored to the inclined concrete base slab of the intake structure, by approved means, at sufficiently close centres to ensure that the wire rope shall not contact the concrete.

(ii) The brackets and rollers shall be of steel construction and the roller pins and anchor bolts shall be of corrosion resistant steel.

f. Indicators

The following indicators shall be mounted on the door of local control cabinet;

(i) Source voltmeter

(ii) Load ampere meter

(iii) Indicating light for "Gate Raising"

(iv) Indicating light for "Gate Lowering"

(v) Indicating light for "Gate Fully Raised"

(vi) Indicating light for "Gate Fully Lowered"

(vii) Indicating light for "Emergency Upper Limit"

(viii) Indicating light for "Over Load"

(ix) Indicating light for "Rope Slack"

(x) Indicating light for "Gate Resting"

(xi) Indicating light for "Filling Valve Opened"

(xii) Indicating light "Source Power"

(xiii) Indicating light for "Control Power"

(xiv) Buzzer for indicating overload, emergency upper limit and rope slacking.

g. Push Button Controls

The following push button controls shall be furnished on the local control panel:

(i) Push button for "Raise"

(ii) Push button for "Stop"

(iii) Push button for "Lower"

(iv) Push button for "Lamp Test"

(v) Push button for "Buzzer Stop"

h. Terminals

Terminals required for all indicating information shall be furnished in the local control cabinet for monitoring at the dam control office.

12.8.7 Spare Parts

The Contractor shall furnish and deliver the following spare parts to the Employer's store:

a. 100 % of fuses for local control cabinet;

b. One magnetic contactor, five auxiliary relays and one timer of each type used;

c. Two indicating lights of each type used;

12.8.8 Tolerances

a. Gate Leaf

The gate leaf shall be accurately manufactured and installed within the following tolerances;

Points to be Measured	Tolerances (mm)
Gate leaf width	5
Gate leaf height	6
Gate leaf depth	3
Diagonal length difference	7
Distance centre to centre of wheels	5
Distance between rope centres	6
Distance between sealing line of side seal rubbers	5/m
Distance from sealing line of side seal rubber to centre of wheel tread	+2, -0

b. Guide Frame

The Guide frames shall be accurately manufactured and installed within the following tolerances;

Points to be Measured	Tolerances (mm)
Clear span	5
Distance centre to centre of track plate	5
Flatness of side sealing plate	0.5/m
Straightness of side sealing plate	1.5
Flatness of track plate	0.5/m
Straightness of track plate	1.5
Flatness of sill seal plate	0.5/m
Straightness of sill seal plate	1.5
Flatness of lintel seal plate	0.5/m
Straightness of lintel seal plate	1.5

c. Other Tolerance

Any tolerance not specified herein shall be defined by the Contractor and shall be subject to the Engineer's approval.

12.8.9 Leakage

The leakage from seals shall be less than 0.2 litre/s per one metre of sealing length.

12.9 EMERGENCY GATE FOR OUTLET WORKS

12.9.1 General

a. This Clause specifies the detailed technical requirements for the design and manufacture of the emergency gate for the intake structure to be furnished in accordance with this Section of the Specification. These requirements supplement and/or modify the applicable requirements of other relevant Clauses of this Section of the Specification.

b. The Emergency gate equipment shall include the following major items described in this Clause.

(i) One slide-type gate leaf;

(ii) One set of guide frames;

(iii) One set of wire rope hoist;

(iv) One set of lifting beam;

(v) Spare parts as listed in this Clause

12.9.2 Functions and Operations

a. Functions

The emergency gate is used when it is necessary to discharge a reservoir under WL.130.000 water surface. The emergency gate shall always be operated under balanced pressure conditions.

b. Operations

The emergency gate shall be operated and controlled, by operator(s), from local control panels only.

12.9.3 Design conditions

a. General Data

Type of Gate	: Steel made slide gate
Number of Gate	: 1 set
Design Water Level	: WL.130.000
Wave Height	: 0.8 m
Sill Level	: EL. 115.000
Lintel Seal Elevation	: EL. 115.900
Clear span	: 2.000 m
Clear Height	: 1.40 m
Gate Height	: 1.650 m
Operating Water Level	: Balance Pressure (or WL.136.000 & WL.131.000)

Water Seal	: Rubber seals at all sides of downstream face of gate leaf
Type of Hoist	: Electrically Driven 1 Motor 1 Drum Wire Rope Hoist and Lifting beam
Operating Speed	: 0.1 m/min10%
Operation	: Local Control
Power Source	: 380V 50Hz 34W
Rising Height	: Normal 2.0 m more Maintenance 67.0 m more
Seismic Intensity for Design	: k = 0.16
Corrosion Allowance	: 1.0 mm (one face)
Allowable Stress	
For Steel	: Tension, Compression 1.125y/2 as a basic shear 1.125y/2/3
For Concrete	: Bearing 60.0 kgf/cm^2
	Shearing 4.0 kgf/cm^2
	Bond 7.0 kgf/cm^2

b. Hydrostatic Load

Hydrostatic Load shall be calculated from the design water level of WL.130.800.

12.9.4 Gate Leaf

a. Sectionalising

Gate leaf shall not be sectionalised.

b. Skin plate

The skin plate shall be on the downstream face of the gate leaf. The skin plate shall be welded to the main girders, vertical sub-beams and side beams, etc. by continuous welding.

c. Main Girders

The main girders shall be arranged in such a manner that each main girder shall be arranged at equal intervals and shall sustain almost the same amount of design load. The main girders shall be of the built-up girder and/or C-beam type steel construction.

d. Bearing plate

(i) The bearing plate shall sustain the water load and transfers it to embedded guide frame and shall make the movement of gate leaf smooth in operation.

(ii) The gate leaf shall slide between upstream and downstream bearing plates and guides in the slot of gate body. The bearing plates shall be made of corrosion resistant steel and the coefficient of friction shall be under 0.4.

(iii) The matching bearing plates on the gate leaf shall be manufactured from bronze casting and be secured to the gate leaf by countersunk hexagon-head, corrosion resistant, steel bolts.

e. Lifting Beam

The lifting beam shall be designed to automatically engage and disengage, for raising and depositing the emergency gate. The emergency gate shall be suitable to be operated by the lifting beam. The lifting beam shall be provided with lifting attachments for wire rope.

12.9.5 Guide Frames

a. The guide frame from EL.115.000 to EL.152.800 shall be embedded in second stage concrete. Anchor bolts and/or bars shall be provided in first stage concrete around the block-out or recess for erection, alignment and restraint of the embedded guide frame.

The upstream guide frame shall be furnished with an appropriate support frame of the trash rack for emergency gate. The downstream guide frame shall included side guides.

The guide frame above EL.152.800 shall be exposed as shown on the Drawings. The support structure shall be included as part of this exposed guide frame and shall be suitably anchored to the first stage concrete to the Engineer's approval.

All sections of the guide frame shall be made continuous by approved means.

b. Sill Beam

The Contractor shall set the sill elevation of the emergency gate in accordance with the details shown on the drawings. The sill beam shall be embedded in the second stage concrete works.

c. Lintel Frame

The lintel frame shall be set at the level shown on the drawings. The lintel beam shall be embedded in the second stage concrete works.

d. Seal Plate

Seal plates shall be of corrosion resistant steel. Side seal, sill seal and lintel seal plates shall be continuous to ensure water-tightness and shall be furnished only in locations where it is necessarily to seal.

12.9.6 Hoist

a. Hoisting Height

The bottom lip of the gate leaf shall be lifted up at least to EL. 152.800.

b. Rope Slack and Overload Detector

The hoist shall be provide with a rope slack detector and overload detector. The rope slack detector shall be included in the hoist frame and near the wire rope sheave. The overload detector shall detect over-current. When these detectors are functioning the motor shall be electrically disengaged.

c. Resting Device

(i) The hoist shall be provided with a gate leaf resting device which shall be operated manually. The resting device shall enable the gate leaf to rest at the position with the bottom of the gate leaf being above EL.152.800.

(ii) The resting device shall be attached to the hoist base frame or exposed guide frame above EL.152.800.

d. Wire rope

Wire rope shall be to JIS G 3525 6 x 37, A-type wire rope or equivalent and galvanised.

e. Wire Hole Guides

(i) Roller-type wire rope guides shall be furnished and anchored to the inclined concrete base slab of the intake structure and trash rack, by approved means, at sufficiently close centres to ensure that the wire rope shall not contact the concrete and trash rack.

(ii) The brackets and rollers shall be of steel construction and the roller pins and anchor bolts shall be of corrosion resistant steel.

f. Indicators

The following indicators shall be mounted on the door of local control cabinet;

(i) Source voltmeter

(ii) Load ampere meter

(iii) Indicating light for "Gate Raising"

(iv) Indicating light for "Gate Lowering"

(v) Indicating light for "Gate Fully Raised"

(vi) Indicating light for "Gate Fully Lowered"

(vii) Indicating light for "Emergency Upper Limit"

(viii) Indicating light for "Over Load"

(ix) Indicating light for "Rope Slack"

(x) Indicating light for "Gate Resting"

(xi) Indicating light for "Filling Valve Opened"

(xii) Indicating light "Source Power"

(xiii) Indicating light for "Control Power"

(xiv) Buzzer for indicating overload, emergency upper limit and rope slacking.

g. Push Button Controls

The following push button controls shall be furnished on the local control panel:

(i) Push button for "Raise"

(ii) Push button for "Stop"

(iii) Push button for "Lower"

(iv) Push button for "Lamp Test"

(v) Push button for "Buzzer Stop"

h. Terminals

Terminals required for all indicating information shall be furnished in the local control cabinet for monitoring at the dam control office.

12.9.7 Spare Parts

The Contractor shall furnish and deliver the following spare parts to the Employer's store:

(i) 100 % of fuses for local control cabinet;

(ii) One magnetic contactors, five auxiliary relays and one timer of each type used;

(iii) Two indicating light of each type used;

12.9.8 Tolerances

a. Gate Leaf

The gate leaf shall be accurately manufactured and installed within the following tolerances;

Points to be Measured	Tolerances (mm)
Gate leaf width	5
Gate leaf height	6
Gate leaf depth	3
Diagonal length difference	7
Distance center to center of wheels	5
Distance between rope centers	6
Distance between sealing line of side seal rubbers	5/m
Distance from sealing line of side seal rubber to centre of wheel tread	+2, -0

b. Guide Frame

The Guide frames shall be accurately manufactured and installed within the following tolerances;

Points to be Measured	Tolerances (mm)
Clear span	5
Distance centre to centre of track plate	5
Flatness of side sealing plate	0.5/m
Straightness of side sealing plate	1.5
Flatness of track plate	0.5/m
Straightness of track plate	1.5
Flatness of sill seal plate	0.5/m
Straightness of sill seal plate	1.5
Flatness of lintel seal plate	0.5/m
Straightness of lintel seal plate	1.5

c. Other Tolerance

The tolerance not specified herein shall be defined by the Contractor and subject to the Engineer's approval.

12.9.9 Leakage

The leakage from seals shall be less than 0.20 litre/s per one metre sealing length.

12.10 STEEL CONDUIT FOR OUTLET WORKS

12.10.1 General

a. This Clause specifies the detailed technical requirements for the design and manufacture of the steel conduit to be installed in the outlet tunnel and outlet works in accordance with this Section of the Specification. These requirements supplement and/or modify the applicable requirements of other relevant Clauses in this Section of the Specification. Connection piece between Guard Gate and Control Gate : as required.

b. The steel conduit shall consist of the following major items described in this Clauses :

(i) Outlet pipe including transition pipe, bending pipe, branch and reducer.

c. The layout and arrangement of the steel conduit shall be as shown the Drawings.

12.10.2 Design Conditions

a. General Data

Number of Conduits : 1 set

Dimensions

Transition pipe : 1,400 mm × 1,400 mm to 1,400 mm dia.

Outlet pipes : 1400 mm dia, 650 mm dia, 250 mm dia.

Lengths

Transition pipe : 1,150 mm

Outlet pipes : 1,400 mm dia (VIP1 Branch): 399.511 m
650 mm dia (Branch Guard Valve): 16.210m
250 mm dia (Branch (0.650 m): 9.056m

Guard Valve : Length included in main length of pipe.

Connection piece between Guard Gate and Control Gate : as required

b. Design pressure

See table at next page

c. Critical Loading Case

The Contractor may limit his design calculation to the critical loading case, if it is evident or can be demonstrated that only one case is critical among cases specified in Table 12.10.2.

d. Design Stress

0.54 σy as basic

1.35 × 0.54 σy shall be adopted when the pipe shell bending stress due to restraining the shell deformation by the ring girder or stiffener ring has been considered.

Safety factor for buckling : 1.5

e. Corrosion allowance

Corrosion allowance shall be 1.5 mm for pipe shell.

TABLE 12.10.2 DESIGN PRESSURE OF STEEL PENSTOCK

	During Construction		Post Construction					
	Case 1		Case 1		Case 2		Case 3	
	I.P	E.P	I.P	E.P	I.P	E.P	I.P	E.P
Transition pipe	Nil	2.0 kgf/cm² Grouting Pressure	HWL 155.300 hw	Nil	Nil	Nil	Nil	NWL 148.9 +hw
Outlet pipe 1,400 mm dia 650 mm dia 250 mm dia	Nil	2.0 kgf/cm² Grouting Pressure	HWL 155.300 hw	Nil	SWL 151.8 +Po	Nil	Nil	Nil

Notes: IP = Internal Pressure
EP = External Pressure
hw = 0.8 m (Wave height due to wind)
Po = Water Hammer Pressure(See Fig Water Hammer, I.P and E.P)

12.10.3 Transition Pipe

The transition pipe shall have rectangular cross section of 1,400 mm square at the upstream and have circular cross section of 1,400 mm diameter at the downstream end. The transition length shall be 1,150 mm as shown on the Drawings. The transition pipe shall be designed to endure the specified external and internal pressures without taking into consideration any additional strength given by the surrounding concrete. The transition pipe shall be connected to the downstream end of the gate guide of the bulkhead gate by full penetration butt welding.

12.10.4 Outlet Pipe

a. General

(i) The outlet pipe shall be installed in the outlet tunnel and encased in concrete except in the outlet operation room as shown on the Drawings. The outlet pipe shall be connected with the transition pipe by continuous full penetration butt welding. The outlet pipe shall include bend pipes, branch pipes, reducer pipes and connection pipes with the guard gate and hydropower station as shown on Drawings. After the first pipe bend, the outlet pipe will

be installed at a downward gradient of 1 vertically to 14.65 horizontally.

(ii) A sleeve expansion joint shall be provided in the outlet operation room before the guard gate.

(iii) The reducer pipes shall be provided as shown on the Drawings.

b. Bend

The bend shall be made up of short segments of pipe with mitred ends. The deflection angle between segments shall not exceed 7 degrees.

c. Minimum Thickness

The minimum thickness of pipe shell used for the pressure lining part shall be greater than those determined from the following formula if stiffeners are not used. The minimum thickness of pipe shell shall not be less than 6 mm even if the pipe diameter is small and stiffeners are used, including the corrosion allowance of 1.5 mm.

Minimum thickness of pipe shell shall include the corrosion Allowance of 1.5 mm.

d. Stiffener Rings

Stiffener rings shall be required to avoid excessive pipe shell thickness under the condition of the pipe being subjected to uniform external pressure. The stiffener rings shall be of single plate bar attached perpendicularly to the outside of the pipe shell with continuous welding. The size and the intervals of the stiffener rings will be left to the discretion of the Contractor.

e. Stress to be Considered

The following stresses shall be examined and combined for checking the strength against internal pressure.

(i) Circumferential tensile stress of pipe shell due to internal pressure.

(ii) The reducer pipes shall be provided as shown on the Drawings.

$$\sigma a = \frac{p \times D}{2 \times t}$$

where

p : Internal pressure in kg/cm²

D : Inside diameter of pipe shell in cm

t : Thickness of pipe shell in cm.

(iii) Local bending stress of pipe shell due to restraining the shell from bulging by the stiffener rings. The direction of stress is longitudinal.

$$\sigma b = 1.82 \times \frac{tr \times hr}{Ar} \times \sigma a$$

where

tr : Thickness of stiffener ring plate in cm

hr : Height of stiffener ring plate in cm

Ar : Area of combined section in cm²

$$: tr \times hr + t \times \left(1.56\sqrt{rm \times t} + tr\right)$$

rm : Radius of centre of pipe shell plate in cm.

(iv) Longitudinal stress due to temperature variation

$$\sigma c = \alpha \times E \times \Delta T$$

where

α : Coefficient of linear expansion of steel
: 1.2×10^{-5}/degree Centigrade

E : Young's modulus of steel
: 2.1×10^{6} kg/cm²

ΔT : Temperature variation ±15 degrees Centigrade.

(v) Longitudinal stress due to Poisson's effect.

$$\sigma d = \nu \times \sigma a$$

where

ν : Poisson's ratio = 0.3.

f. Safety Analysis for Buckling

The connecting pipe shell shall be capable of withstanding the specified external pressure when the pipe is empty. The safety factor for the pipe shell against buckling shall not be less than 1.5.

(i) Pipe Shell

The critical buckling pressure of the pipe shell shall be calculated by the following formula developed by S. Timoshenko.

$$Pk = \frac{E \times t}{(1-\nu^2) \times ro} \times \left[\frac{1-\nu^2}{(n^2-1) \times m^2} + \frac{t^2}{12 \times ro^2} \times \left\{ (n^2-1) + \frac{2n^2-1-\nu}{m} \right\} \right]$$

where

Pk : Critical buckling pressure depends on n in kg/cm².

$$m = 1 + \left(\frac{n \times L}{\pi \times ro} \right)^2$$

ro : Radius of outside of pipe shell plate in cm

L : interval of stiffener rings in cm

n : number or wrinkles ≥ 2.

(ii) Stiffener Rings

The evaluation of safety against buckling for stiffener rings shall be done by applying the formula developed by E. Amstutz.

$$\sigma cr = \sigma N \times \left\{ 1 - \frac{ro}{e} \times \frac{\sigma F - \sigma N}{(1+1.5\pi) \times E} \right\}$$

where

σ cr : Critical buckling stress of stiffener rings in kg/cm²

e : Distance between the natural axis of stiffener composite section and the inner surface of pipe in cm.

σ F : Yield strength of material in kg/cm²

σ N : shall be computed by following equation through trial and error method.

$$\left(4 \times 10^{-4} + \frac{\sigma N}{E} \right) \times \left(1 + \frac{rm^2}{i^2} \times \frac{\sigma N}{E} \right)^{1.5}$$

$$= 1.68 \frac{rm}{e} x \frac{\sigma F - \sigma N}{E} x \left(1 - 0.25 x \frac{rm}{e} x \frac{\sigma F - \sigma N}{E}\right)$$

where i : Radius of gyration of stiffener composite section in cm.

The mean compressive stress of stiffener ring shall be expressed as follows:

$$\sigma c = \frac{C x T}{S} x ro x p$$

where

P : Design external pressure in kg/cm²

T $= tr + 1.56\sqrt{rm x t}$

S $= tr x (t + hr) + 1.56 x t x \sqrt{rm x t}$

$$C = 1 + \frac{2 x \left(\frac{1}{T x t} - \frac{1}{S}\right) x ro^2}{\frac{3}{\{3(1 - \nu^2)\}^{0.75}} x \left(\frac{ro}{t}\right)^{1.5} x K + \frac{2 ro^2}{S}}$$

where

$$K = \frac{\sinh(\beta L) + \sin(\beta L)}{\cosh(\beta L) - \cos(\beta L)}$$

$$\beta = \frac{\{3(1 - \nu^2)\}^{0.25}}{\sqrt{rm x t}}$$

Thus design criteria shall be $\sigma cr / \sigma c > 1.5$.

12.10.5 Fabrication

a. Bending plates

(i) 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.

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

(iii) The longitudinal welds of adjacent pipe units of fabricated conduit shells shall not be continuous through the girth weld. Minimum separation between such longitudinal welds shall be 30° rotation of individual pipe units.

(iv) Stiffener rings, thrust collars and seepage rings shall not be welded at or near girth weld without approval and all connection pieces and manholes shall not be located at or near longitudinal or girth welds.

b. Welding

(i) Full penetration butt welding shall be used for a longitudinal and girth welding in the conduit shell. For butt welding of plates of unequal thickness the work of trimming of the thicker plate shall

be done at the Contractor's fabrication shop, if the difference between plate thickness is more than 3.0 mm.

(ii) All weld joints shall be dressed smooth and the maximum weld reinforcement shall be limited to the under mentioned tolerances. Welds shall be dressed free of all flux and scale and smoothed to the extent necessary to allow radiographic examination.

TOLERANCE OF WELD REINFORCEMENT

Plate Thickness (mm)	Maximum Weld Reinforcement (mm)
Less than 12	1.5
12 to 25	2.5
More than 25	3.0

12.10.6 Tolerances

The steel conduit shall be accurately manufactured and installed within the following tolerances:

Points to be measured	Tolerances (mm)
Length of unit pipe block	8
Breath of Transition	5
Height of Transition	6
Circumferential length of cylinder pipe	
1,400 mm in diameter	10
650 mm in diameter	4.5
250 mm in diameter	1.5
Circularity	
dia. max - dia min.	< 1.0 % of dia.
Centerline alignment of conduit	6

12.11 CONTROL GATES FOR OUTLET WORKS

12.11.1 General

a. Scope

This Clause specifies the detailed technical requirements for the design and manufacture of the control gates to be provided at the downstream and of the outlet pipe in accordance with this Section of the Specification. These requirements supplement and/or modify the applicable requirements of other relevant Clauses in this section of the Specification. The control gates are to be manufactured by an experienced manufacturer and details of similar experience shall be provided in the Tender.

Specified requirements hereunder apply to both of the control gates unless otherwise stated.

b. There shall be two sets of control gates; one in the major outlet works (650 mm dia) and the other in the minor outlet works (250 mm dia).

c. Each control gate shall consist of the following major items described in this Clause:

(i) One control gate leaf;

(ii) One set of bonnet and bonnet cover;

(iii) One set of electrically driven screw spindle hoist(valve control)

(iv) One conical enlarger with flanged connection to gate;

(v) One connecting length, between guard gate and conical enlarger;

(vi) One set of outlet conduit pipe and air pipe;

(vii) Spare parts as listed in this Clause;

d. Installation

Each control gate shall be installed perpendicularly to the longitudinal axis of its respective outlet pipe.

12.11.2 Functions, Operations and Hydraulics

a. Functions

(i) The Contractor shall provide two set of the control gates as described above. The control gates regulate the discharge required downstream of the dam, while the hydropower station is not in operation, or not yet complete. The major outlet works shall discharge 6.0 m^3/s and the minor outlet works shall discharge 0.60 m^3/s.

(ii) The control gate shall be satisfactorily operated at all openings without vibration or cavitation damage.

b. Operations

(i) The control gates shall be operated and controlled, by operator(s) from local control panels.

(ii) The control gates shall be capable of future automatic control operation by setting the required discharge at the dam control office and initiating the supersonic flow meter provided on the outlet pipe.

12.11.3 Design Conditions

a. General Data

(i) For Major Outlet Works

Type of Gate	: Jet flow gate
Number of Gate	: 1 set
Water Level	
Design Water Level	: SWL.151.800 + Water Hammer
Operation Water Level	: HWL.155.300 + Wave height 0.8 m
Elevation of Orifice Centre	: EL.85.900
Orifice Diameter	: 650 mm

	Water Seal	: Circular seal by metal contact on upstream face of gate leaf
	Type of Hoist	: Electrically driven screw spindle type hoist (valve control)
	Operation	: Local and capable of future remote control
	Operation Speed	: 0.1 m 10 %
	Power Source	: 380V, 50Hz, 3, 4W
	Corrosion Allowance	: 1.0 mm (One face)
	Allowable Stress	: Tension, Compression 0.5y as a basic shearing 0.5y / 3
	Allowable Deflection	: 1 / 2000 (Gate leaf)
(iii)	For Minor Outlet Works	
	Type of Gate	: Jet flow gate
	Number of Gate	: 1 set
	Water Level	
	Design Water Level	: SWL.151.800 + Water Hammer
	Operation Water Level	: HWL.155.300 + Wave height 0.8 m
	Elevation of Orifice Centre	: EL.85.450
	Orifice Diameter	: 250 mm
	Water Seal	: Circular seal by metal contact on upstream face of gate leaf
	Type of Hoist	: Electrically driven screw spindle type hoist (valve control)
	Operation	: Local and remote control
	Operation Speed	: 0.1 m 10 %
	Power Source	: 380V, 50Hz, 3, 4W
	Corrosion Allowance	: 1.0 mm (One face)
	Allowable Stress	: Tension, Compression 0.5y as a basic shearing 0.5y / 3
	Allowable Deflection	: 1 / 2000 (Gate leaf)

b. Load due to Seal Ring

The let flow gate shall be provided with a floating seal ring which is forced to contact with the gate leaf the upstream pressure. The Contractor shall take to load due the seal ring into account when he design the structure.

12.11.4 Gate Structure

a. Gate leaf

(i) Gate leaf shall be slide type and shall be designed to make the sliding slot as narrow as possible.

(ii) The upstream face of the gate leaf which is in sliding contact with the seal shall be made, of machine finished corrosion-resistant steel.

(iii) The bottom of gate leaf shall be made with a slope of about 30 degrees upward to provide sufficient air when the gate is partially open for regulating discharge.

b. Gate Guide

(i) The gate leaf shall slide between upstream and downstream bearing plates and guides in the slot of gate body. The bearing plates shall be made of corrosion resistant steel.

(ii) The matching bearing plates on the gate leaf shall be manufactured from bronze casting and be secured to the gate leaf by countersunk hexagon head corrosion resistant steel bolts.

c. Seal Assembly

(i) From a point approximately one diameter upstream from the face of the gate leaf, the conical diffuser shall be provided at a slope of 1 radially to 10 longitudinally to a diameter of 120% of the jet orifice. From this point the nozzle shall be sloped at an angle of 45 degrees with the axial centre line to produce a jet which will spring clear of the gate leaf slots.

(ii) The seal assembly shall consist of conical nozzle, seal ring, clamp ring and other components.

(iii) The conical nozzle shall be forged steel and shall be welded to the downstream end of the conical diffuser.

(iv) The seal ring shall be of bronze casting which shall withstand the distributed torque moment due to upstream pressure.

(v) The sloped surface of conical nozzle and the seal ring shall from a truncated nozzle and the slope end of the seal ring shall provide a definite spring point of the orifice.

(vi) The clamp ring shall be provided to hold the seal ring from downstream with sufficient freedom of movement. The clamp ring shall be of corrosion resistant steel and be arranged to remove the seal ring easily from downstream for maintenance.

d. Bonnet and Bonnet Cover

(i) Bonnet structure shall be designed to withstand the load on the seal ring and gate leaf on which design internal pressure acts, and to withstand external pressures due to establishing concrete works.

(ii) The downstream of the gate slot shall open widely enough to permit sufficient air supply and prevent excessive pressure drop.

(iii) The bonnet cover shall be provided on the top of the bonnet. The flange of bonnet and bonnet cover shall be connected by corrosion resistant bolts and nuts.

(iv) The top of the bonnet shall be so designed that the gate leaf can be pulled out if it is required for maintenance after removing the hoist and the bonnet cover.

12.11.5 Hoist

a. Hoisting Height

The gate leaf shall be raised enough to remove the seal ring for maintenance. The hoisting rod shall be corrosion resistant steel.

b. Position Indicator

A mechanical valve position indicator shall be furnished and shall be mounted in the valve control hoist.

c. Indicators

The following indicators shall be mounted on the door of the local control cabinet;

(i) Source voltmeter

(ii) load ampere meter

(i) shall be in common with guard gate

(iii) Analogue type position indicator

(iv) Indicating light for "Local Control"

(v) Indicating light for "Remote Control"

(vi) Indicating light for "Manual Control"

(vii) Indicating light for "Gate Opening"

(viii) Indicating light for "Gate Closing"

(ix) Indicating light for "Gate Opened"

(x) Indicating light for "Gate Closed"

(xi) Indicating light for "Over Load"

(xii) Indicating light for "Over Torque"

(xiii) Indicating light for "water Pressure Balance"(For Emergency Outlet Works)

(xiv) Indicating light for "Source Power"

(xv) Indicating light for "Control Power"

(xvi) Buzzer for indicating items (xi) and (xii).

Items (xvi) shall be in common with guard gate.

(xvii) Digital indicator for supersonic flow meter.

d. Push Button Control

e. The following push button control shall be furnished on the local control cabinet:

(i) Push button for "Open"

(ii) Push button for "Stop"

(iii) Push button for "Close"

(iv) Push button for "Lamp Test"

(v) Push button for " Buzzer Stop"

(vi) Items (iv) and (v) shall be in common with guard gate.

f. Spare Parts

The Contractor shall furnish and deliver the following spare parts to the Employer's store :

(i) 100% of fuses for local control cabinet;

(ii) One magnetic contactor, five auxiliary relays and one timer of each type used;

(iii) Two indicating lights of each type used;

12.11.6 Tolerances

The control gates unit shall be accurately manufactured and installed within the tolerances specified in the manufacture's standard. The tolerances shall be defined to satisfy the function of the control gate. The Contractor shall submit the tolerances to the Engineer for approval.

12.11.7 Maintenance

The control gates shall be designed and maintenance devices shall be furnished to permit then to be dismantled by the geared trolley, furnished in accordance with Sub-Clause "Geared Trolley", within the confines of the control gate house.

12.12 GUARD GATES FOR OUTLET WORKS

12.12.1 General

a. Scope

This Clause specifies the detailed technical requirement for the design and manufacture of the guard gates to be provided and located upstream of the control gates in accordance with this section of the Specification. These requirements supplement and/or modify other relevant Clauses in this Section of the Specification.

Specified requirements hereunder apply to both of the control gates unless otherwise stated.

b. There shall be two sets of guard gates; one in the major outlets (650 mm) and the other in the minor outlet works (250 mm dia).

c. Each of the guard gate shall consist of the following major items described in this Clause:

(i) One set of guard gate leaf;

(ii) One set of bonnet and bonnet cover;

(iii) One set of electrically driven screw spindle hoist (valve control)

(iv) One set of air pipe and air valve;

(v) One set of by-pass device (for major outlet works only);

(vi) Spare parts as listed in this Clause;

d. Installation

The guard gates shall be installed perpendicularly to the longitudinal axis of outlet pipe.

12.12.2 Functions and Operations

a. Functions

The guard gates are for the purposes of emergency use and maintenance of control gates. The guard gates are always standing-by in their fully raised positions and operated to shut off the flow of water in case the control gates become inoperable. These gates are usually operated under balanced pressure no-flow conditions, except for closure in emergencies.

b. Operations

The guard gate shall be operated and controlled, by operator(s), from local control panel.

12.12.3 Design Conditions

a. For Major Outlet Works

Type of Gate	: High Pressure Slide Gate
Number of Gate	: 1 set
Water Level	
Design Water Level	: SWL.151.800 + Water Hammer 28.6 m
Operating Water Level	: Raising Water Pressure Balance
	Lowering HWL.155.300 + Wave height 0.8 m
Elevation of Centre	: EL.85.900
Nominal Diameter	: 0.650 m
Water Seal	: Circular seal by metal contact
	on downstream side of gate leaf
Type of Hoist	: Electrically Driven Screw Spindle type (Valve Control)
Operation Speed	: 0.1 m/min10%
Power Source	: 380V, 50Hz, 3, 4W
Corrosion Allowance	: 1.0 mm(One Face)
Allowable Stress for Steel	: Tension, Compression 0.5y
	as a basic shearing 0.5y / 3
Allowable Deflection	: 1 / 2000(For Gate Leaf)

b. For Minor Outlet Works

Type of Gate	: High Pressure Slide Gate
Number of Gate	: 1 set
Water Level	
Design Water Level	: SWL.151.800 + Water Hammer 28.6m
Operating Water Level	: Raising Water Pressure Balance
	Lowering HWL.155.300 + Wave height 0.8 m
Elevation of Centre	: EL.85.450
Nominal Diameter	: 0.250 m

Water Seal	: Circular seal by metal contact on downstream side of gate leaf
Type of Hoist	: Electrically Driven Screw Spindle Type (Valve Control)
Operation Speed	: 0.1 m/min10%
Power Source	: 380V, 50Hz, 3, 4W
Corrosion Allowance	: 1.0 mm (One Face)
Allowable Stress for Steel	: Tension, Compression 0.5y as a basic shearing 0.5y / 3
Allowable Deflection	: 1 / 2000(For Gate Leaf)

12.12.4 Gate Structure

a. Gate Leaf

Gate leaf shall be made of cast or welded steel provided with bronze seal seat. The upstream seat shall be inclined and water-tightness shall be accomplished by the wedge effect of the inclined seal seat.

b. Bonnet and Bonnet Cover

(i) Bonnet structure shall be designed to withstand the internal pressure of design water head.

(ii) The bonnet cover shall be provided on the top of the bonnet through flange to flange connection. The connection shall be made with corrosion resistant bolts and nuts.

(iii) The top of the bonnet shall be so designed that the gate leaf can be pulled out if it is required for maintenance after removing the hoist and bonnet cover.

12.12.5 Hoist

a. Hoisting Height

The gate leaf shall be raised enough so as not to obstruct the water flow and not to induce vibration of the leaf due to the flow. The hoisting rod shall be made of corrosion resistant steel.

b. Position Indicator

A mechanical valve position indicator shall be furnished and shall be mounted on the valve control hoist.

c. Indicators

The following indicators shall be mounted on the door of the local control cabinet;

(i) Source voltmeter

(ii) load ampere meter

(i) shall be in common with guard gate

(iii) Analogue type position indicator

(iv) Indicating light for "Local Control"

(v) Indicating light for "Remote Control"

(vi) Indicating light for "Manual Control"

(vii) Indicating light for "Gate Opening"

(viii) Indicating light for "Gate Closing"

(ix) Indicating light for "Gate Opened"

(x) Indicating light for "Gate Closed"

(xi) Indicating light for "Over Load"

(xii) Indicating light for "Over Torque"

(xiii) Indicating light for "Water Pressure Balance" (For Emergency Outlet Works)

(xiv) Indicating light for "Source Power"

(xv) Indicating light for "Control Power"

(xvi) Buzzer for indicating items (xi) and (xii)

Item (xvi) shall be in common with guard gate.

(xvii) Digital indicator for supersonic flow meter.

d. Push Button Control

The following push button control shall be furnished on the local control cabinet:

(i) Push button for "Open"

(ii) Push button for "Stop"

(iii) Push button for "Close"

(iv) Push button for "Lamp Test"

(v) Push button for " Buzzer Stop"

Items (iv) and (v) shall be in common with guard gate.

e. Spare Parts

The Contractor shall furnish and deliver the following spare parts to the Employer's store :

(i) 100% of fuses for local control cabinet;

(ii) One magnetic contactors, five auxiliary relays and one timer of each type used;

(iii) Two indicating lights of each type used;

12.12.6 Tolerance

The guard gate unit shall be accurately manufactured and installed within the tolerances specified in the manufacturer's standard. The tolerances shall be defined to satisfy the function of the guard gate. The Contractor shall submit the tolerances to the Engineer for approval.

12.12.7 Maintenance

The guard gate shall be designed and maintenance devise shall be furnished to permit it to be dismantled using the geared trolley, furnished in accordance with Sub-Clause "Geared Trolley", within the confines at the control gate house.