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SECTION TS 25. MINOR METALWORK ITEMS

25.1 GENERAL

25.1.1 Scope

This Section covers the designing, manufacturing, transporting, installing, coating and other common requirements incidental to all metal works to be furnished under the contract. The metal works herein specified shall mean steel works such as handrails, ladders, stairways, fences, gates, etc., to be provided in accordance with the Drawings or as directed by the Engineer.

Specific requirements for major metalwork item such as gate for the weir are specified elsewhere.

25.1.2 Submittals

The Contractor shall prepare shop drawings showing complete details, sections and plans of all parts, assemblies, materials lists, components, connections and supports, and relations to the structures based on the Drawings. The shop drawings are subject to approval by the Engineer in accordance with Clause 1.4.3. of the General Specification.

25.1.3 Standards

Unless otherwise specifically provided in this Specification, the metal works shall be manufactured, fabricated and installed in accordance with the latest provisions of JIS, or other equivalent standards approved by the Engineer.

All materials to be furnished by the Contractor shall be new and shall have the best quality of their respective kinds.

Unless otherwise specified in this Specification, all materials and methods of fabrication shall conform to the standards listed in the following table.

Standards for Metalwork

Item	Standard
Structural Steel	ASTM A36, JIS G3101 or JIS G3106
Structural Steel Pipe	ASTM 120 or JIS G3444
Steel Pipe	JIS G3452
Bolt and Nut	ASTM A307 Grade A or JIS B1180
Arc Welding Electrode	AWS, JIS Z3211
Gas Welding Rod	AWS, JIS 3201
Stainless Steel Plate	JIS G3404 to 3407 SUS304

25.2 FABRICATION AND CONSTRUCTION

25.2.1 General

The Contractor shall be responsible for the correctness and completeness of the shop drawings and for shop fit and field connections. The work shall be shop-fitted and shop-assembled as practicable as possible, conforming to the details on the approved shop drawings.

Where necessary, metals shall be insulated to prevent electrolysis due to contact between dissimilar metals and to prevent corrosion due to contact between metals and masonry or concrete. Insulation shall be by means of bituminous paint or other approved means.

All fastening, anchors and accessories required for fabrication and erection shall be provided by the Contractor. Exposed fastenings shall be kept to an absolute minimum, evenly spaced and neatly set out. Wood plugs will not be permitted.

Workmanship in fabrication shall conform to the best modern shop and field practice. All joints and intersecting members shall be accurately fitted and all works shall be fabricated on true planes with adequate fastenings.

25.2.2 Welding

Welding shall be carried out in accordance with the requirements of the American Institute of Steel Construction (AISC) or approved equivalent and shall conform to the standard code of the American Welding Society or equivalent approved by the Engineer.

The Contractor shall submit, for approval, details of the experience and qualifications of proposed welders. The welders shall have sufficient experience and qualifications for welding work and hold certificates issued by "Balai Latihan Kerja, Departemen Tenaga Kerja (Employment Training Centre, Department of Labour)" or other training course approved by the Engineer.

All welds shall be visually inspected by the Engineer and shall be subject to his approval.

When so directed by the Engineer, welds shall be tested by radiographic tests specified in JIS 3104 or other testing method approved by the Engineer.

Field welding shall not normally be permitted. However, when expressly authorised by the Engineer it shall not be performed under adverse weather conditions of rain, temperature, moisture and wind unless the welding work is protected in a manner approved by the Engineer.

Welding electrodes shall conform to the requirements of JIS Z3211 to Z3212 or equivalent approved by the Engineer.

Welds disapproved by the Engineer shall be chipped out to sound metal, tested and repair-welded and subject to the Engineer's approval using a procedure approved by the Engineer prior to carrying out the repair.

25.2.3 Protective Treatment of Metalwork

All minor metalwork shall be treated in accordance with the requirements of Section TS 24 of the Technical Specification using system 11.

All paint materials and colours shall be subject to the Engineer's approval.

25.2.4 Check Sheets

At least seven (7) days before placing concrete in any structure or installing any metal work, the Contractor shall submit, for approval, three (3) copies of an approved checkout sheet detailing all items of metalwork to be installed including unit masses and dimensions for materials to be furnished and installed and receipted invoices or other approved documentary evidence detailing the mass of any item which has been furnished and installed.

25.2.5 Installation

Metal works to be embedded in concrete shall be embedded when the concrete is being placed or, if shown on the Drawings or directed by the Engineer, recesses or blockouts shall be made in the concrete and the metalwork shall be grouted in place using cement or embedded in second-stage concrete.

The surfaces of all metal works to be in contact with concrete shall be thoroughly cleaned immediately before the grout or concrete is placed.

Metal works shall be accurately positioned and aligned in the locations as shown on the Drawings, and shall be held securely in the correct position during placing and setting of the concrete.

Where it is impracticable to place anchors or anchor bolts required for the installation of metal work when the concrete is placed, holes shall be drilled into the concrete after the concrete has set for 28 days and expansion bolts, adhesive anchor bolts, or other approved anchors shall be installed.

Field welding, cutting or drilling of prefabricated galvanised metalwork items shall not be permitted without the written approval of the Engineer.

25.3 MEASUREMENT AND PAYMENT

25.3.1 Steel Fence

Measurement shall be made of the length of steel fence installed and approved by the Engineer.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and all incidental items and work for completing the steel fencing in accordance with the Drawings and the Specification.

The following pay item shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
G.2.3	Steel Fence (with Anti-corrosion Painting)	m
L.2.14	Steel Fence (with Anti-corrosion Painting), H=110cm	m

25.3.2 Handrails and Stairs

Measurement shall be made of the mass of steel handrails and stairs installed and approved by the Engineer.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and incidental costs for completing the handrail and stairs in accordance with the Drawings and the Specification.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
G.2.1	Steel Handrails	kg
G.2.2	Steel Spiral Stairs	kg
G.3.1	Furnishing and Installing Steel Handrails in Maintenance and Approach Bridges	kg

25.3.3 Expansion Joint

Measurement shall be made of the length of expansion joint installed and approved by the Engineer.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and incidental costs for completing the expansion joint in accordance with the Drawings and the Specification.

The following pay item shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
G.3.2	Expansion Joint, Steel Profile (75 mm x 6 mm)	m

25.3.4 Car Barrier

Payment shall be made at the lump sum price entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and incidental costs for completing 2 units of car barriers in accordance with the Drawings and the Specification and to the approval of the Engineer.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
G.3.3	Car Barrier at Entrance of both Right and Left Banks	LS

25.3.5 Steel Ladder

Payment shall be made at the lump sum price entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and incidental costs for completing furnishing and installation of a steel ladder in accordance with the Drawings and the Specification and to the approval of the Engineer.

The following pay items shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
I.1.3	Steel Ladder (with Anti-corrosion Painting)	LS

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SECTION TS 26. GATES AND ANCILLARY FACILITIES

26.1 GENERAL

This section covers the requirements for the gates and all related facilities to be provided for the Simongan Weir and for other adjacent off-take structures.

26.1.1 Scope of Work

The work shall include the design, material arrangement, manufacturing, testing, inspecting, painting, packing, insurance, transportation from the shop to the site (including customs clearance), storage, installation, commissioning, in-situ tests and inspections, taxes, completion and rectification of defects. General descriptions of the gates are as follows:

Flood Discharge Gates (3 No.)

(1) Gate Leaf

Type : Shell Type Steel Roller Gate (Overflow type)
Dimension : Clear span 18.50 m x Clear height 3.70 m
Sealing System : Bottom and sides at upstream side of gate

(2) Hoist System

Type : Rope drum operated by electric motor
Operation : Local control at Control House and remote control at Operation/Management Office

(3) Gate Guide Frame

Type : Steel Guide Frame (Bottom and Sides) (including secondary concrete)

Sediment Flush Gates (2 No.)

(1) Gate Leaf

Type : Plate Girder Type Steel Roller Gate (Under-flow type)
Dimension : Clear span 5.50 m x Clear height 4.35 m
Sealing System : Bottom and sides at upstream side of gate

(2) Hoist System

Type : Rope drum operated by electric motor and manual operation
Operation : Local control at Control House and remote control at Operation/Management Office

(3) Gate Guide Frame

Type : Steel Guide Frame (Bottom and Sides)

Right Bank Intake Gates (4 No.)

(1) Gate Leaf

Type : Steel Slide Gate
Dimension : Clear span 2.25 m x Clear height 2.00 m
Sealing System : Top, bottom and sides at downstream side of gate

(2) Hoist System

Type : Single spindle operated by electric motor
Operation : Local control at Control House and remote control at Operation/Management Office

(3) Gate Guide Frame

Type : Steel Guide Frame (Bottom, Sides and Top)

Left Bank Intake Gates (2 No.)

(1) Gate Leaf

Type : Steel Slide Gate
Dimension : Clear span 2.00 m x Clear height 2.00 m
Sealing System : Top, bottom and sides at downstream side of gate

(2) Hoist System

Type : Single spindle operated by electric motor
Operation : Local control at Control Deck and remote control at Operation/Management Office

(3) Gate Guide Frame (2 gate)

Type : Steel Guide Frame (Bottom, Sides and Top)

Temporary Gate

(1) Gate Leaves for Flood Discharge and Sediment Flush Portions

Note that this item is for dual purpose use. For flood discharge gate application all of the 6 panels plus the 2 steel vertical mullions (posts) will be used. Alternatively, for the sediment gate application, the two narrower panels will be used. It is not intended that the both a flood gate plus a sediment flush gate will be closed using components of the temporary gate components simultaneously.

Type of Gate: Steel Slide Gate (2 stage gates)

Dimension of Openings :

- For Flood Discharge Portion:
Clear span 18.50 m x Clear height 4.50 m
- For Sediment Flush Portion:
Clear span 5.50 m x Clear height 4.50 m
- Size of Slide Gate Panels:

6.22m x 2.25m x 2 x 2 sets and 5.94m x 2.25m x 1 x 1 set

Sealing System : Bottom and sides at upstream side of gate

(2) Gate Guide Frame

Type :

When used in any of the 3 Flood Gate positions, the guide frames shall be steel guide frames plus 2 sets of vertical steel mullions (posts) connected to the maintenance bridge (at the top).

When used for the Sediment Gate application the guide frames shall be steel guide frames.

26.1.2 Standards and Criteria

Except where requirements are specifically stated elsewhere, the Work shall comply with the latest version of standards and criteria listed below or such standards and criteria which are equivalent or superior to the listed ones which are accepted broadly throughout the world.

- (1) Japanese Industrial Standards (JIS)
- (2) Technical Standard on Dam and Weir Equipment, Japan Association of Dam and Weir Equipment (JADEE)
- (3) Manual for River Works in Japan, River Bureau, Ministry of Construction, Japan
- (4) Specification for Highway Bridges, Japan Road Association

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

26.1.3 Standardisation

Widely used products in the international markets shall be used and measures shall be taken to standardize certain parts of the equipment to be supplied under the Contract in order to facilitate the stock, maintenance, replacement, interchangeability, etc.

This requirement is applicable to the following:

- Terminals and terminal racks
- Indicating instruments and meters
- Auxiliary relays
- Conductors, fuses
- Motor protection switch
- Control devices
- Lights, bulbs plugs, sockets
- Electromagnetic switches
- 3E relays
- Locks for local control cabinets

The final decision on the type of the above items shall be decided by the Engineer and shall be incorporated in the shop Drawings to be provided by the Contractor in accordance with the provisions of clause 1.4 of the General Specification.

26.1.4 Submittals

The Contractor shall submit the following documents for the Engineer's approval in accordance with the provisions of clause 1.5 of the General Specification.

26.1.4.1 Document List

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

26.1.4.2 Design Computations

The Contractor shall submit comprehensive design computations for the Engineer's approval.

26.1.4.3 Drawings

Drawings to be submitted shall include all Shop Drawings and any other Drawings and diagrams used for fabrication and construction of the gates and their related facilities.

Drawings shall include, but not be limited to, structural layout, assembly Drawings, foundations, cable connections, piping, piping systems. Details shall include dimensions, welding details, code compliance and all other information for the manufacture, assemble and commissioning of the gates and related systems.

Drawings shall conform to the general requirements described in the General Specification.

26.1.4.4 Materials List

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

26.1.4.5 Welding Manual

The welding manual shall include details of all welding procedures proposed to be used in the Works including butt and fillet weld procedure qualifications, qualification criteria for welding operators and testing and a list of proposed welders.

26.1.4.6 Painting Manual

A painting manual shall be based on the Section TS 24, of the Technical Specification, Protective Treatment of Metalwork, referred to in this section and the manufacturing and inspection requirements described hereunder for all protective treatment of metalwork.

26.1.4.7 Detailed Program

The detailed programme shall show details of fabrication, installation and key dates for inspections etc. The programme shall be integrated with and consistent with the overall construction programme described in clause 1.5 of the General Specification.

26.1.4.8 Test and Inspection Manual

The test and inspection manual shall include details of all tests and inspections to be performed throughout all stages of procurement, manufacturing, assembly and commissioning of the gates and related systems. It shall also include dates and locations of all inspections to be performed.

26.1.4.9 Operation and Maintenance Manual

The Contractor shall prepare and submit an operation and maintenance manual for the guidance of operators and maintenance personnel.

The manual shall include but not be limited to detailed technical information of all equipment and system relating to the gates, recommended inspection and maintenance schedules and other guidelines for operators as recommended by the suppliers of specialised equipment.

26.1.4.10 Reports of Tests and Inspections

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

26.1.5 Materials

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

Material to be used:

- (a) Material of gate leaf
Material shall comply with "Technical Standard on Dam and Weir Equipment " or equivalent or better standards.
- (b) Welding material
The most suitable welding material shall be selected taking account of material and strength of parent metals and welding conditions. However, in this case the Contractor shall obtain the Employer's approval.
- (c) Sealing material
Material shall comply with the "Technical Standard on Dam and Weir Equipment " or equivalent or better standard.
- (d) Bolts, Nuts and Washers
Bolts, nuts and washers used for bolted connections shall be those specified in ISO or equivalent or better standard.

26.1.6 Name Plates

Name plates shall be attached in locations indicated by the Engineer. The description shall include Employer's name, name of gate, type, clear span, gate height, operating speed, max. design head, material, gate weight, year and month of manufacture, and builder's name, in accordance with the wording and format approved by the Engineer.

Other items of equipment shall be labelled in accordance with specialist suppliers' normal practice.

26.1.7 Spare Parts

The following spare parts shall be provided following the prior approval of the Engineer:

- Lamp and fuse for control circuit : more than 100% of existing materials
- Auxiliary relays : more than one piece for each kind of existing materials
- Conductors : more than one piece for each kind of existing materials
- Power fuse (if installed) : more than one set (for 3 phases) for each kind of existing materials
- Spare box: necessary quantities
- Other necessary parts: necessary quantities

26.1.8 Tools

The Contractor shall supply all accessories necessary for the finished equipment and also each kind of the tools necessary for assembling and dismantling the equipment.

26.1.9 Storage of Tools and Spare Parts

Tools and spare parts shall be stored in steel lockable boxes suitable for their intended purpose, to be supplied by the Contractor.

26.2 DESIGN CRITERIA

26.2.1 Design Stresses

(1) Allowable Stress of Materials

Allowable stresses shall comply with "Technical Standard on Dam and Weir Equipment (JADEE) Chapter 2", or equivalent standard approved by the Engineer.

(2) Increase in Allowable Stress during earthquake

This item shall comply with "Technical Standard on Dam and Weir Equipment (JADEE) Chapter 2", or equivalent or better standards.

26.2.2 Design Data

(1) Design Loads

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

In calculating design loads the following parameters shall be considered:

- (a) Hydrostatic loads shall be calculated with a specific weight of 1.00 t/m³ for fresh water.
- (b) Earthquake effect shall be calculated by applying a horizontal coefficient of 0.12.
- (c) Wind load for all structures shall be 150 kg / m² over the entire exposed area.
- (d) Gravity acceleration shall be 9.8 m/s².
- (e) Range of temperature shall be 15 degrees C to 40 degrees C

(2) Material of Main Structural Members

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

(3) Corrosion Allowance

Water contact face for skin plate : 1.0 mm (one side)

Face if skin plat not in contact with water : 0.5 mm (one side)

Other main members : 1.0 mm (one side)

(4) Minimum Thickness

Skin plate : not less than 6 mm (including corrosion allowance)

Other members: not less than 5 mm (including corrosion allowance)

(5) Deflection of Gate Leaves

Deflection : 1/800 of span maximum

(6) Connection Methods for Each Member

Connection of members shall be done by welding, bolted connections or riveted joints. High strength bolt joints shall not be used. At any one connection, the application of plural connection methods shall not be allowed. However, this

provision shall not apply for temporary connections for installation etc.

(7) Welding Joint Efficiency

Welded joint efficiencies for gates shall be in accordance with the following tables
Butt Welded Joint Efficiency

	Radiographic test or ultrasonic test conducted (%)	Radiographic test or ultrasonic test not conducted (%)
Shop Welding	95 (100)	85
Field Welding	90 (95)	80

() means the case radiographic or ultra sonic test is conducted for the entire weld line.

Fillet Welded Joint Efficiency

Shop Welding	95 %
Field Welding	90 %

(8) Design Features of Gates

Flood Discharge Gates

Item	Contents			
Type	Shell Type Steel Roller Gate (overflow type)			
Quantity	Three (3) sets			
Clear span	18.500 m			
Clear Height	3.700 m			
Design Water Level	Upstream side EL. 6.200 m			
	Downstream side EL. 1.500 m			
Operating Water Level	Opening	Upstream side	Closing	Upstream side
		EL. 6.200 m		EL. 2.500 m
		Downstream side		Downstream side
		EL. 1.500 m		EL. 1.500 m
Height of Estimated Sedimentation	1.00 m			
Elevation of Gate Floor Slab	EL. 1.500 m			
Sealing System	Watertight rubber Bottom and sides at upstream side of gate			
Hoisting System	Rope drum operated by electric motor			
Operating Speed	0.3 m / min.			
Distance between lowest and uppermost ends of gate	7.500 m			
Control System	Local control at control House and remote control at Operation /management Office			
Main Power Source	380V, 50Hz			
Control Power Source	220V, 50Hz			

Sediment Flush Gate

Item	Contents			
Type	Plate Girder Type Steel Roller Gate (underflow type)			
Quantity	Two (2) sets			
Clear span	5.500 m			
Clear Height	4.350 m			
Design Water Level	Upstream side EL. 6.200 m			
	Downstream side EL. 1.500 m			
Operating Water Level	Opening	Upstream side	Closing	Upstream side
		EL. 6.200 m		EL. 2.500 m
		Downstream side		Downstream side
		EL. 1.500 m		EL. 1.500 m
Height of Estimated Sedimentation	1.00 m			
Elevation of Gate Floor Slab	EL. 1.500 m			
Sealing System	Watertight rubber Bottom and sides at upstream side of gate			
Hoisting System	Rope drum operated by electric motor and manual operation			
Operating Speed	0.3 m / min.			
Distance between lowest and uppermost ends of gate	7.500 m			
Control System	Local control at control House and remote control at Operation /management Office			
Main Power Source	380V, 50Hz			
Control Power Source	220V, 50Hz			

Right Bank Intake Gate

Item	Contents			
Type	Steel Slide Gate			
Quantity	Four (4) sets			
Clear span	2.250 m			
Clear Height	2.000 m			
Design Water Level	Upstream side EL. 8.000 m			
	Downstream side EL. 3.800 m			
Operating Water Level	Opening	Upstream side	Closing	Upstream side
		EL. 6.200 m		EL. 5.850 m
		Downstream side		Downstream side
		EL. 3.800 m		EL. 5.000 m
Height of Estimated Sedimentation	Not applicable			
Elevation of Gate Floor Slab	EL. 3.800 m			
Sealing System	Top, bottom and sides at downstream side of gate			
Hoisting System	Single spindle operated by electric motor and manual operation			
Operating Speed	0.3 m / min.			
Distance between lowest and uppermost ends of gate	2.500m			
Control System	Local control at Gate Shed at Operation /management Office			
Main Power Source	380V, 50Hz			
Control Power Source	220V, 50Hz			

Left Bank Intake Gate

Item	Contents			
Type	Steel Slide Gate			
Quantity	Two (2) sets			
Clear span	2.000 m			
Clear Height	2.000 m			
Design Water Level	Upstream side EL. 8.000 m			
	Downstream side EL. 4.000 m			
Operating Water Level	Opening	Upstream side	Closing	Upstream side
		EL. 6.200 m		EL. 5.850 m
		Downstream side		Downstream side
		EL. 4.300 m		EL. 4.700 m
Height of Estimated Sedimentation	Not applicable			
Elevation of Gate Floor Slab	EL. 4.000 m			
Sealing System	Top, bottom and sides at downstream side of gate			
Hoisting System	Single spindle operated by electric motor and manual operation			
Operating Speed	0.3 m / min.			
Distance between lowest and uppermost ends of gate	2.500 m			
Control System	Local control at Gate Shed at Operation /management Office			
Main Power Source	380V, 50Hz			
Control Power Source	220V, 50Hz			

Temporary Gate

Item	Contents
Type	Steel Slide Gate (Stop log)
Quantity	One (1) set (2 types)
Clear span	Type-1: 18.500 m, Type-2: 5.500 m
Clear Height	4.000m
Design Water Level	Upstream side EL. 8.000 m
	Downstream side EL. 1.500 m
Elevation of Gate Floor Slab	EL. 0.900m
Sealing System	Watertight rubber Bottom and sides at upstream side of gate
Hoisting System	By track crane

26.2.3 Design Particulars

(1) General

- (a) The gate leaves, guide frames and gate hoists shall have necessary strength and rigidity for the conditions indicated in this section of the specification and shall have adequate safety factors against vibration and buckling and the gate leaves and guide frame shall have safety factors against buoyancy.
- (b) The gate leaves and guide frames shall maintain the necessary water

tightness, shall be reliable in operation, and shall have suitable structures for operation and maintenance.

- (c) The following design particulars shall apply to all gates to be provided by the Contactor except where it is noted that certain features apply to particular gates.

(2) Gate Leaves

- (a) Appropriate drain holes shall be provided to prevent rust in the main horizontal girders where entrapment of water is possible.

(3) In providing drain holes, the diameter of holes shall be 50mm or more and the location of holes shall be selected without adversely affecting the strength of structure.

- (b) The skin plate shall be fabricated with main horizontal girders and vertical stiffeners, and shall be welded completely all around with fillet welds to the above members.

- (c) The connections of main member shall be by welding. Where field welding is carried out it shall be performed in such a manner that welding distortion will be reduced to a minimum and deformation of and residual stress in gate leaves will not occur.

- (d) Side rollers shall be provided on each side of gate leaves so that the gate leaves can be smoothly operated. (Applicable to Flood Gates and Sediment Flush Gates only)

- (e) Ballast shall not be used to assist the closing of gates

- (f) Gate leaves shall be designed to have sufficient strength for the case of being suspended by one side only.

(4) Roller and Sheave

- (a) Main rollers shall be positioned to support approximately equal loading and shall be designed and constructed not to allow excess unbalanced load.

- (b) In order to allow for deflection of the gate leaves, where necessary curvature shall be provided for the rim of the roller. (Applicable to Flood Gates and Sediment Flush Gates only)

- (c) In members where the main roller shaft penetrates the diaphragm or end stiffener the gate shall be reinforced with double plates and the axle of rollers or sheave shall be provided with locking plates to prevent rotation.

- (d) Two side rollers or more shall be provided on each side of gate. (Applicable to Flood Gates and Sediment Flush Gates only)

(5) Seals

- (a) In designing seals consideration shall be given to the type of seal, the method of initial fitting and replacement. Particular attention shall be given to the water-tightness at corners. Seal shall be sufficiently strong to be resistant to stream damage when gates are partially open and they should not cause harmful vibration or cavitation.

- (b) The seal rubber shall have necessary strength, elasticity, and durability. The seal rubber also shall have necessary compression set and shall not cause excess friction nor turn up during operation

- (c) The seals shall be fixed to the gates by means of stainless steel bars and secured with stainless steel bolts and nuts at approximately 100mm centers.
- (d) Rubber seals shall be continuous to the extent possible and shall contain as few joints as possible.

(6) Gate Guide Frames

- (a) Guide frames shall be of suitable structures and dimensions for their respective gates.

The structure of the guide frames shall be designed such that they easily accommodate gate leaves and shall have sufficient strength to bear all loads imposed on them by the gates.

The roller rail tread shall be of corrosion resistant steel with shall have a higher hardness than the roller tread. (Applicable to Flood Gates and Sediment Flush Gates only)

- (b) The sealing member of the guide frames shall be provided with stainless steel bar (equivalent to SUS 304) at least 6 mm thick, and shall be flush and smooth.
- (c) The blockout in the concrete to accommodate guide frames shall be accurately formed so as to avoid the need for chipping or drilling for the purpose of installing guide frames.
- (d) Steel anchor bars shall be installed during the concrete construction stage of the work.

(7) Gate Hoist

(a) General

- (i) Gate hoists shall be of sufficient capacity to operate the gates at the required speed, shall be sufficiently durable to sustain a long working life and shall be easily controlled and maintained.
- (ii) Hoists shall be covered with a protective steel plates with inspection openings with covers with hand grips for ease of access for inspection and lubrication.
- (iii) Inspection openings shall be as wide as practicable for ease of access and covers shall be as light enough in weight to permit easy manual removal and replacement. Metal thickness of covers should not exceed 3mm.
- (iv) Hoists shall be arranged such that they can be operated safely.
- (v) Steel gratings shall be provided to cover the apertures for wire ropes and any other openings or hazards.

(b) Electric Motor

- (i) All electric motors shall be a totally enclosed watertight, 3 phase induction of double squirrel cage type. Rating shall be continuous.
- (ii) Electric motor shafts shall be equipped with automatic fail-safe brakes which will operate immediately in the event of a power failure or other event necessitating their use.

(c) Brake

If brakes without a self-lock system (such as cycloid-reduction gears) are

used, an additional brake system, independent of the electric motor, shall be provided.

(d) Reduction Gears

- (i) The reduction gears shall have sufficient strength for the intended purpose, shall have high durability, shall be easily maintained and shall have high efficiency.
- (ii) Enclosed-type reduction gears shall be equipped with oil surface meters, drain-plugs and feeder openings.

(e) Power Transmission Shafts and Bearings

- (i) Power transmission shafts shall have sufficient strength and stiffness for the imposed effects attributed to the transmitted power by the automated system including torsion and bending effects. Shafts shall be supported by three or more bearings.
- (ii) Manual grease pumps shall be provided for lubricating bearings.

(f) Gears

- (i) Gears shall be made using purpose-built gear cutting machines. The meshing of the gears shall be smooth and shall operate quietly. Gear reduction steps shall not be excessive.
- (ii) Both ends of gears shall be slightly chamfered and the smaller gears shall be slightly wider than the larger gears.
- (iii) The gear and drum shall form an integral unit with the two components connected by means of bolts in reamed holes or other suitable method. (Applicable to Flood Gates and Sediment Flush Gates only).

(g) Drums (Applicable to Flood Gates and Sediment Flush Gates only)

- (i) Rope drums shall be a rope groove type. Grooves shall be smoothly machined.
- (ii) The drum lengths and the number of grooves shall be such as to accommodate the full length of ropes in one layer without overlapping and have at least one groove spare when gates are in their highest position and at least 3 dead turns of rope remaining on drums when the gates are in their lowest positions.
- (iii) If rope drums are of fabricated steel construction they shall be stress relieved.

(h) Wire Rope (Applicable to Flood Gates and Sediment Flush Gates only)

- (i) Wire rope shall be pre-tensioned wire rope of high quality from a long-established, reputable supplier. The diameter of wire rope after pre-tensioning shall not be less than the required diameter based on design loads.
- (ii) Wire rope shall be galvanized steel or made from stainless steel.
- (iii) Wire rope ends shall be swaged and fitted with metal alloy sockets.
- (iv) Adjusting devices shall be provided on both sides of gates at the ends of wire ropes for the adjustment of wire rope lengths.

(i) Gate Supports

Gate support devices shall be equipped with safety suspenders and swing

preventers capable of functioning when the gates are in their fully raised positions. (Applicable to Flood Gates and Sediment Flush Gates only).

(j) Manual Hoisting Equipment

Manual hoisting equipment shall be so designed that the maximum required operating force to be applied by an operator is 98 N (10 kgf). A ratchet or similar device shall be fitted to prevent operating handles being turned in the reverse direction should a handle be released during operation.

(8) Control Equipment

- (a) Power to be supplied shall be three-phase four-wire AC 380V, 50Hz. Control equipment shall be designed such that it can be operated even with voltage fluctuations of $\pm 10\%$ and frequency fluctuation of $\pm 1\text{Hz}$.
- (b) Gate operation shall be from either local control panels or the remote control panel. Hoist operation, by means of the push buttons at the local control panels, shall have priority over the remote control panel. Interlocks shall be provided to prevent operation from remote control panels during operation from the local control panels. Changeover switches between the local control panels and the remote control panel shall be installed at local control panels.
- (c) Hoist operation shall be effected by the use of three push buttons: eg. "Open", "Close", "Stop". Restarting after a "Stop" command shall be possible except when gates are in their fully-open or fully-closed positions.
- (d) All local control panels and the remote control panel shall display "Operating Condition" or the "Failure Condition". During failure mode gates shall be stopped and an audible alarm shall sound. Items to be displayed during failure mode are shown in the following table.

Display Items for Failure Mode

Failure Items	Specification	Failure Items	Specification
1. Rope overload	(R)	7. Heater, breaking down of wire	(R)
2. 3E relays operation	(R)	8. De-humidifier, breaking down of wire	(R)
3. Thermal relay operation	(R)	9. Emergency upper limit	(R)
4. Contact	(R)	10. Emergency lower limit	(R)
5. Rope looseness	(R)	11. MCB trip	(R)
6. Power source	(R)	12. Spare space	(W)

Display Items for Operating Mode

Operation Items	Specification	Operation Items	Specification
1. Gate Lifting	(R)	8. Gate full closed	(W)
2. Gate Lowering	(G)	9. Power source	(W)
3. Gate stopped	(R)	10. Electronic motor	(W)
4. Gate full opened	(G)	11. Manual operation	(Y)
5. Hook in position	(R)	12. Heater ON	(W)
6. Hook disengaged	(G)	13. Dehumidifier ON	(W)
7. Valve full opened	(R)	14. Spare space	(W) 2 sets

Legend: "()" indicates the color of lamp (G: Green, R: Red, W: White Y: Yellow).

- (e) The power source of all control systems shall be alternating current.
- (f) Space heaters and dehumidifiers at local control cabinets shall continue to be operational at all times including times when the main circuit is in the off mode.

(9) Stand-by Generator System

The stand-by generator system shall be a purpose-built, skid mounted, diesel engine and generator which is to supply power to various facilities in the event of failure of the normal commercial power supply. Facilities to be supplied by the stand-by generator systems shall be all electric motors for the gate operation system, control systems, safety systems, office management facilities etc.

- (a) The system shall start automatically in the event of a power failure or shall be capable of being started manually.
- (b) The stand-by generator shall be durable, suitable for purpose and shall be simple to operate and maintain.

(10) Local Control Panel, Remote Control Panel and Wiring

(a) General Items

- (i) The control system, comprising the local control panels, remote control panel and wiring shall be designed and installed in accordance with the Drawings, the relevant standards, the required operating criteria to the approval of the Engineer. The control system shall incorporate all the required features for the safe operation of the weir gates and related equipment.
- (ii) The control system shall be durable, reliable, easily maintained and be designed such that components are interchangeable.
- (iii) The control system shall have a minimum insulation resistance of 5 M Ω
- (iv) Earth wires connected to each item of electric equipment shall be connected to the earth terminals of control panels.

(b) Control Panels

- (i) Local control panels shall be of the free-standing outdoor type. They shall be weather-proof within steel cabinets made of 3 mm minimum thickness steel plate, damp proof, dust proof and shall have a full-face lockable doors.
- (ii) The remote control panel shall incorporate the same features as the local control panel but shall be of the indoor type.
- (iii) Wiring in panels shall consist of chloride vinyl cable with the diameter of at least 2 mm², and shall be connected with outside points on terminal plates. All terminals shall consist of pressure connectors.
- (iv) Ammeter, voltmeter, gate position indicator displays shall be installed such that they are visible through windows from outside.
- (v) Cables connected at the rear face shall be marked with terminal numbers at both ends and the relevant numbers shall be included on the plug board chart.
- (vi) Dehumidifiers that have sufficient capacity to keep equipment inside

control cabinets dry shall be included in every control cabinet. The dehumidifiers shall be of automatic compulsive convection type. When the humidity inside control panels exceeds 60%, the dehumidifiers will start operation of compulsive convection.

- (vii) Control cabinets shall be equipped with the following for easy and reliable control.

Items	Quantity
Main Switch (with alarm contact)	1 piece
Switch (with alarm contact)	Required
Voltmeter (1.5 grade)	1 piece
Ammeter (1.5 grade)	1 piece
Positive-negative magnetic switch	Required
3E relay	Required
Auxiliary relay	Required
Displays (current, raise, lower, stop, failure, etc.)	Required
Push button for switch	Required
Space heater (with thermostat)	1 piece
Dehumidifier	1 piece
Material for wiring	Required
Plug receptacle for working (200V, 100V)	1 piece each
Terminate plate	Required
Name plate	for each equipment
Door (full-face door, small door for operating), with lock	1 piece each
Lighting in cabinet (fluorescent lamp of 10 W)	1 piece
Chime, alarm bell	1 piece each
Other required equipment	Required

- (viii) Sound level and quality of chime and alarm bell shall be sufficiently loud so as to be audible during normal operation.

- (ix) The leader lining from single phase shall be conducted following consideration of the loading balance of each phase.

- (x) The space heater circuit, dehumidifier circuit and motor circuit shall be constructed independently and each shall be equipped with circuit breakers.

- (c) Gate Position Indicator (For Flood Gates and Sediment Discharge Gates only)

- (i) Gate position indicators shall be provided for each gate and shall be mounted in positions on the hoist frames where they are easily visible.

- (ii) The gate position shall be displayed by means of two hands. The longer hand shall be calibrated to indicate 1.00 m per rotation and the shorter hand shall indicate the number of metres with a full 360 degrees indicating the gate fully opened position.

- (d) Wiring

Power source for gate operation shall be based on three-phase, four-wire and AC 380V, 50Hz at terminal trip in the power panel.

The power cable from the power panel to the local control panel and the power cable and control cable from the local control panel to each equipment shall be laid in the conduit pipe. The power cable and control cable from the

local control house to the operation/management office building shall be buried below ground level and protected by conduit and cable tiles.

26.2.4 Lubricating Oil

The lubricating oil and grease shall be selected on the basis of the expected range of operation temperature and durability.

26.3 MANUFACTURING

26.3.1 General

- (1) All work shall be performed strictly in accordance with the approved documents submitted by the Contractor in accordance with clause 25.1.3 of this section of the Technical Specification.
- (2) All work shall be performed and completed in a thorough workmanlike manner and shall follow the best modern practices in the design and manufacture of all equipment. All work shall be done by personnel skilled in the professions and trades relevant to the work they perform.

26.3.2 Manufacturing

- (1) Manufacturing shall be carried out strictly in accordance with the approved shop drawings and the approved manuals in a manner which shall not cause harmful influences to the materials used.
- (2) Marking on the material shall be made by ink or punch; chisels shall not be used for such purposes.
- (3) The steel plates use for the main members of all gates shall be arranged to the extent possible, such that the direction of principal stresses under loading will be consistent with the direction of rolling.
- (4) The steel plates used for the main members shall be cut by automatic gas cutting and the steel sections shall be cut by high speed cutting machine.
- (5) Gears, journal parts of shaft and screws shall be machined and finished smoothly.
- (6) The steel materials used for the main members shall be bent uniformly and exactly by press or bending machine.
- (7) All holes for bolts shall be drilled accurately and shall be reamed if required.
- (8) Cast iron materials shall not be welded. Cutting for stainless steel shall be carried out by machine, plasma jet or other appropriate methods.

26.3.3 Shop Assembly

- (1) During shop assembly of members adequate support shall be used to ensure that forces other than self weight are not imposed.
- (2) During shop assembly joints which are to be field-bolted shall be fitted with at least 30% of the bolts in each joint.
- (3) Match marks shall be used on adjacent components to assist field assembly.

26.3.4 Jointing

(1) Welding

(a) General

- (i) All welding shall be carried out in accordance with the approved Welding Manual referred to clause 17.1.4, Submittals.
- (ii) Welding rods and flux for automatic welding shall be used under sufficiently dry condition in accordance with the approved Welding Manual.
- (iii) All A.C. arc welding machines shall be equipped with automatic shock prevention devices.

(b) Welding works

- (i) Butt welding or fillet welding shall be applied to important joints which transmits stress in accordance with the approved shop drawings. Any changes required to be made to the approved Welding Manual or to the procedures therein shall be subject to the approval of the Engineer.
- (ii) Welded joints between different sections of the same members shall be made using full penetration butt welds unless otherwise approved by the Engineer.
- (iii) Prior to welding, components to be butt welded shall be adjusted carefully and precisely assembled in a manner so as to prevent undue stresses, strains or distortion of the components.
- (iv) Surfaces to be welded shall be cleaned to remove water, oil, grease, rust, paint and any other foreign matter.
- (v) While butt welding, back welding shall be carried out by back chipping to the sound welded layer.
- (vi) All fillet welded joints shall be made by using continuous fillets welds. The minimum sizes of fillet welded joints shall be as follows:

Plate Thickness	Continuous Fillet
9 mm and over	5mm
6 mm to 9 mm	4mm

For T-joints in plates having thicknesses less than 6 mm the minimum size of the weld shall be that of the thinner plate.

Boxing shall be made at the end of all fillet welds except where it is not possible, in which case, return welding shall be made.

- (vii) Sizes and tolerance of weld metal at welded joint shall not exceed those shown below.

Height of excess weld metal of joint :

- Plate thickness 12mm and under : 3 mm
- Plate thickness over 12mm to 25mm and under : 4 mm
- Plate thickness over 25mm : 6 mm

Size of offset of joint :

- Plate thickness 25mm and under : 2 mm
- Plate thickness over 25mm : 3 mm

- (viii) For manually welded joints the root gap shall be as shown below:

Butt joint :

- I-type groove joint : 3mm
- Other type groove joints : 5mm

Fillet joint : 2mm

(ix) Weld of jig and tack welding

(i) Fixing jigs by welding for the purpose of assembly shall be minimized.

(ii) Tack weld shall be avoided as much as possible. Defective tack welds, if inevitably made, shall be removed before final welding.

(xi) During adverse weather conditions adequate protection shall be provided.

(c) Preheating

Proper preheating shall be conducted according to material types, plate thickness and prevailing atmospheric conditions.

(d) Quality and work procedure control

(i) The sequence of welding shall be arranged so as to reduce residual stress and deformation as much as possible

(ii) Welds which fail inspection shall be removed by arc air gouging in accordance with approved weld repair procedures.

(iii) Repairing of under-cuts greater than the allowable value shall be done with built-up welding for a length of 50 mm or more following the required preheating.

(2) Bolted Connections

All defective bolts shall be replaced.

26.3.5 Painting

All protective treatment of metalwork shall be done in accordance with the approved Painting Manual which shall be based on the provisions of Section TS 24, Protective Treatment of Metalwork, of this Specification.

26.4 INSTALLATION

26.4.1 General

The various gates and related equipment shall be installed in strict accordance with the approved detailed program referred to in clause 17.1.4.

26.4.2 Installation

(1) Gate leaves shall be installed in accordance with the method statement which has had the prior approval of the Engineer. The methods used shall ensure that no damage will be caused to or excessive loads will imposed upon the gate leaves, guide frames or other component.

(2) Guide frames shall be accurately set in position and secondary concrete shall be placed only following satisfactory checks regarding their accuracy and alignment.

- (3) Installation of the temporary gate comprising steel panels (stoplogs) and mullions (steel posts) shall be carried out from the Maintenance Bridge simulating normal operating conditions utilising a mobile crane. The temporary gate shall be installed in each of the 3 floodgate positions and in the sediment flush gate position to demonstrate its suitability for purpose.
- (4) Following approval of the temporary gate installed in each of the above locations, the components shall be re-inspected, any damage repaired, then placed in the designated storage facility.

26.5 TESTS AND INSPECTIONS

26.5.1 General

All tests and inspections shall be carried out in accordance with the approved Test and Inspection Manual.
The results of all test and inspections shall be subject to the Engineer's approval.

26.5.2 Material Inspection

Mill certificates for all major steel components shall be provided by the Contractor for the Engineer's review.

The Contractor shall carry out other tests and inspections on materials in accordance with the Tests and Inspection Manual and shall submit reports of sufficient detail to demonstrate the suitability for purpose to the Engineer for his approval.

The Engineer, shall have the right to witness all material tests.

When so directed by the Engineer the Contractor shall supply material samples of the type and quantity for independent testing by the Engineer. The cost of such independent testing shall be borne by the Employer. Any defect found as a result of such inspection shall be rectified by the Contractor at his cost.

26.5.3 Purchasing Article Inspection

All items purchased by the Contractor for incorporation in the Works shall be inspected by the Contractor. The Contractor shall submit reports of such inspections to the Engineer for approval of the items purchased

26.5.4 Welding Inspection

- (a) The Contractor shall perform radiographic tests on butt welds in accordance with JIS Z 3104 immediately after completion of welding, and shall submit the results of such tests for the Engineer's approval.

All butt welds in the main flood discharge gate leaves shall be tested at the rate of 20% in accordance with the above standard. Other butt welds shall be tested at the rate of 5%. When results meet the requirement for class 2 in JIS Z 3104 the component or length of weld, for which the radiographic inspection was representative, may be deemed acceptable.

When unacceptable welds are detected the entire weld for which the inspection was representative shall be subjected to radiographic inspection. Defective welds shall be repaired in accordance with approved repair procedures and radiographic tests repeated.

- (b) Where radiographic test cannot be carried out on welds related to joint

efficiency, ultrasonic examination shall be carried out in place of radiographic testing, and the Contractor shall submit the results of such tests to the Engineer for his review and approval.

- (c) The Engineer may direct to where welding test and inspection shall be performed.
- (d) Liquid penetrative dye tests shall be carried out on fillet welds for skin plates, beams and hanging brackets for gate leaves and the Contractor shall submit the results of such tests to the Engineer for his review and approval.

26.5.5 Shop Assembly Inspection

(1) Gates

(a) Trial Assembly Inspection

- (i) After completion of fabrication in the shop, gates shall be inspected by trial assembly inspection prior to painting at the Contractor's shop. The Contractor shall submit the results of such inspection for the Engineer's approval.
- (ii) Allowable difference for dimension of product shall accord to the following calculation results, but no excess of ± 20 mm shall be allowed. Allowable dimensional tolerances shall be determined from the following formula but in no case shall it exceed ± 20 mm

Allowable tolerance: (ϵ)

$$\epsilon = \pm \frac{\epsilon_0}{2} \left(1 + \frac{L}{10} \right) \quad (\text{cm})$$

where, ϵ_0 : Standard allowable difference in case that L is 10 cm long (mm)

L : Length of the member or portion length of the member (m)

- (iv) Items which have dimensions outside the allowable tolerance limits shall be replaced or modified at the Contractor's expense and to the Engineer's approval.

(b) Operating Tests

Function testing shall be conducted in the shop to confirm compliance with the criteria listed in the following table "Function Tests for Electric Driven Hoist Facility". For the purposes of the function testing appropriate test loads shall be applied to simulate site conditions. The Contractor shall submit the results of such inspection for the Engineer's approval.

Function Tests for Electric Driven Hoist Facility

Component	Item	Standard	Remarks
Electric Motor	Current	Standard value or less	
	Voltage	±10% or less	To confirm starting at voltage of 71%
	Rotational frequency	±10% or less	
Reduction Gears	Temperature rising	50 deg C or less	To confirm no oil leakage
Bearing	Temperature rising	40 deg C or less	
Drum	Rotational frequency	±10%	
Limit Switch	Operating test	Confirmation	
Hand-power		98N(10kg f) or less	
Gate Position Indicator		±2% or less	
Brake		Confirmation	
Sound	Abnormal sound	Confirmation	
Vibration	Abnormal vibration	Confirmation	
Operation panel	Sequence test	Confirmation	

- (i) Prior to carrying out operating tests the Contractor shall ensure that all components requiring lubrication have been oiled or greased sufficiently.
- (ii) Operating tests shall be executed with control from the local control cabinets. The use of temporary control cabinets shall not be permitted.

26.5.6 Painting Inspection

The Contractor shall conduct the tests and inspections shown in the following table, and shall submit the report on the results and obtain the Engineer's approval. All painting not approved shall be repaired in accordance with repair procedures approved by the Engineer.

Quality Inspection of Painting Material

Purchasing Article	Inspection Item	Inspection Method & Acceptance Criteria	Remark
Painting material	Type Colour grade Manufacturing date Effective period	Visual check & Certificate of manufacturer	

(1) Visual Inspection

The following shall be inspected.

- (a) Painting faces shall be smooth and not uneven.
- (b) Primary painting shall not be seen through the surface.
- (c) Color tone and gloss shall be uniform and in compliance with the specification.
- (d) Non-uniformity, swelling, cracks and pin holes of painting shall not be permitted.

- (e) There shall be no dripping on the painted surfaces.
- (f) Excessive dirt, spray or dust shall not be found.
- (2) **Painting thickness Examination**
 - (a) Measurement shall be made by a paint film thickness measurement device.
 - (b) Paint thickness shall be measured when the painted surface is touch-dry.
 - (c) Number measurement is three (3) measuring points or more per one main member, or three (3) three parts or more at random per 10 m² (4 points, i.e. top, bottom, both sides at one part.) The average of the readings shall be used as being representative of the inspected area.
 - (d) Where unsatisfactory results are found the area will be re-inspected. If such re-inspection confirms the previous unsatisfactory finding the area shall re-painted and re-inspected.
- (3) **Pin Hole Examination**

Pin hole examination shall be carried out for the upstream side of skin plate using a discharge type detector.

26.5.7 Site Inspections

(1) Inspection during Installation and Trial Operation

At each stage of fabrication and installation of equipment and material, tests and inspections shall be carried out in the presence of the Engineer. The Contractor shall submit to the Engineer reports of such tests and inspections for his review and approval. Inspection of all field welds shall be performed in the same manner as described above for inspection of welds in the shop.

(2) Inspection at Completion

(a) Gates

- (i) Following completion and commissioning of the gates and all their associated systems for operation and control, detailed inspection shall be carried out in the presence of the Engineer as described hereunder and in detail in the approved Testing and Inspection Manual. The Contractor shall submit to the Engineer reports of such tests and inspections for his review and approval
- (ii) Dimensional checks of all gates and guide frames shall carried out at the measurement points listed in the following table and recorded. Embedded components shall be inspected prior to placing concrete.

Measurement Points for Inspection of Gates

Name	Index	Inspection Items	Number of Inspection Points
Gate Leaves	a	Width of gate leaf	Left & Right
	b	Height of gate leaf	
	d	Difference between two diagonal length (d1- d2)	
	e ₁	Distance between main rollers	
	h ₁	Sealing span	
Guide Frames	a	Clear span	Every 2m in height
	b	Centreline distance of wheel track	
	h	Height of guide frame	
	j	Difference between two diagonal length (j1- j2)	Per 1m in length
		Main roller rail flatness	
		Main roller rail straightness	
		Sealing surface flatness	Per 1m in length
	Sealing surface straightness		

- (iii) All seals shall be visually checked under dry conditions to ensure that rubber seals close against the guide frames.
- (iv) The following function tests shall be carried out for the motor driven hoist system. Acceptance criteria shall be the same as those given in the table "Function Tests for Electric Driven Hoist Facility".
- i) Voltage, current, insulation resistance test, and grounding resistor test
 - ii) Temperature rise at each part
 - iii) Rotational frequency of drum (Operating speed)
 - iv) Operating of break
 - v) Operating of limit switch
 - vi) Abnormal sound due to abnormal vibration (Eccentric deflection)
 - vii) Oil leakage
 - viii) Tooth contact marking
 - ix) Operating of gate position indicator
 - x) Operation of hand-powered equipment
 - xi) Sequence test
- (v) Site inspection of all painted surfaces shall be in accordance with Clause 17.5.6. "Painting Inspection"
- (vi) The Contractor shall measure the gaps between rubber seals of gates and gate guide frames utilising a gap gauge after gate installation has been completed.
The Contractor shall submit to the Engineer reports of such tests and inspections for his review and approval.
- (b) Notwithstanding any preliminary approvals resulting from shop inspections, any defects found in the completed work shall be replaced or repaired to the Engineer's approval.

26.6 MEASUREMENT AND PAYMENT

26.6.1 Mechanical Works for Gates

Payment for the various items of mechanical works for the gates shall be made following completion of commissioning, testing, inspection and approval by the Engineer of the system of which respective items are part. Payments shall be made in accordance with the various lump sum prices entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and any other incidental costs necessary for their completion in accordance with the Drawings and the Specification to the Engineer's approval.

The following pay item shall be measured and paid for under this clause:

Pay Item No.	Description	Unit of Measurement
G.1.1	Furnishing and installing Shell Type Steel Roller Gate, H=3.70m x L=18.50m x 3 gates (Flood Discharge Gate)	L.S.
G.1.2	Furnishing and installing Hoist, and Operating and Electrical Equipment for Flood Discharge Gate (3 gates)	L.S.
G.1.3	Furnishing and installing Girder Type Steel Roller Gate, H=4.35 x L=5.5m x 2 gates (Sediment Flush Gate)	L.S.
G.1.4	Furnishing and installing Hoist, and Operating and Electrical Equipment for Sediment Flush Gate (2 gates)	L.S.
G.1.5	Furnishing and installing Steel Slide Gate, H=2.0m x W=2.25m x 4 gates (Right Intake Gate)	L.S.
G.1.6	Furnishing and installing Hoist, and Operating and Electrical Equipment for Right Intake Gate (4 gates)	L.S.
G.1.7	Furnishing and installing Steel Slide Gate, H=2.0m x W=2.0m x 2 gates (Left Intake Gate)	L.S.
G.1.8	Furnishing and installing Hoist, and Operating and Electrical Equipment for Left Intake Gate (2 gates)	L.S.
G.1.9	Furnishing Steel Temporary Gate (including Gate Panels and Posts)	L.S.
G.1.10	Furnishing and Installing Steel Guide Frame for Flood Discharge Gate	L.S.
G.1.11	Furnishing and Installing Steel Guide Frame for Sediment Flush Gate	L.S.
G.1.12	Furnishing and Installing Steel Guide Frame for Right Intake Gate	L.S.
G.1.13	Furnishing and Installing Steel Guide Frame for Left Intake Gate	L.S.
G.1.14	Furnishing and Installing Steel Guide Frame for Temporary Gate (in the Gate Piers, Floor Slabs and Bridge Super-structure)	L.S.