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Pumped Storage (2014) Ltd.

PSPP MANARA

ISRAEL

Particular Hydro-Mechanical Specifications

Intake Roller Gates and Stoplog Gates

Volume 2

Section VIII

Part 2

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REVISION NUMBER

1.0 First edition
2.0 Second edition with updates according lower reservoir elevation adjustments

1 GENERAL

1.1 Scope of Supply

This specification covers the design, manufacture, testing at the factory and site, transportation from factory to site, storage, complete erection, testing and commissioning of

- Stop log gate for the upper reservoir
- Stop log gate for the lower reservoir
- Roller intake gate for the upper reservoir
- Roller intake gate for the lower reservoir
- Assembly and test in the workshop for components as practicable
- Transportation and delivery to site
- Storage at site
- Site installation, commissioning and field acceptance testing
- Corrosion protection of the whole equipment
- Tools for erection installation and maintenance
- Shop and field tests
- Training for the Operational staff
- Operation- and maintenance manuals and full documentation of supplied equipment including as built drawings.

The scope shall include all components which are required for performance, durability and satisfactory operation of the equipment even though not individually or specially stated in this specification.

Unless otherwise indicated the terms upstream and downstream used in this specification always refer to the turbine flow direction.

1.2 Interfaces

The specification is outlined as functional description and therefore does not contain any technical detail design. Internal interfaces of the main components and to other parts of the Contract are summarized in the Volume 2 / Section XI.

1.3 General Technical Design Conditions

In general all technical conditions and design criteria of the General Technical Specifications Annex A apply.

1.4 Data Sheets

The data sheets in Volume 0, Section IV are a technical questionnaire to be furnished in filled-in form with the Tender. They are to be considered as an integral part of the Tender.

2 STOP LOG GATE – UPPER RESERVOIR

2.1 General

The upper reservoir intake of the Manara Project has one intake roller gate located at the beginning of the vertical shaft.

In order to enable maintenance-works on the roller intake gate, the Contractor has to supply one (1) set of stop log for the upper reservoir intake opening. It has to be placed in the grooves upstream of the roller gate. The stop log shall be equipped with a lifting device for mobile crane operation.

The stop log panels shall be stored at deck level together with the necessary lifting device in a storage rack.

The location and general arrangement of equipment is shown in the basic design drawings.

The maximum stop log gate leakage rate at FSL shall be 0,05 l/min per meter of seal. The maximum total leakage of the closed stop log gate must not exceed 1,2 l/min.

The Contractor shall supply the stop log according to the following specification including all auxiliaries necessary for operation and maintenance.

2.2 Scope of Supply

The works under this section include the design, supply, installation, testing and commissioning of the upper reservoir intake stop log complete with all mechanical and safety equipment, spare parts and special tools.

The scope shall include, first and second stage anchor plates and embedded parts as well as any other necessary element to the proper operation of the stop log.

This scope of supply for the upper reservoir intake stop log comprises:

1. One (1) set of stop log gate
2. One (1) set of embedded and built-in parts up to elevation of deck
3. One (1) semi-automatic lifting beam for handling the stop log panels
4. One (1) storage rack for the stop log panels and the semi-automatic lifting beam
5. Spare parts as specified

2.3 Design Data

Stop log gate data	
Type of stop log	Sliding with guide wheels or sliding guide shoes
Number of stop log sets	One (1)
Number of stop log panels per set	Minimum two (2)
Clear span	3.8 m
Clear height	3.8 m
Sealing side	Downstream
Skin plate side	Downstream
Bottom sill level	700.56 m a.s.l.
Deck level	737.75 m a.s.l.
Maximum operation water level (FSL)	737.00 m a.s.l.
Design head	36,44 m
Operating equipment	Semi-automatic lifting beam with mobile crane
Material	EN 10025-2-S355J0
Deflection of main beam	< 1/1000 in relation to the supporting span

For material, design, manufacture and corrosion protection requirements see the corresponding clauses and annexes of the general technical specifications.

2.4 Operation Conditions

Setting and lifting of the stop logs shall be done only under balanced upstream and downstream water pressure. This will be achieved by filling valves integrated in the top stop log panel and operated by the lifting device.

All stop log panels must be designed for FSL condition.

2.5 Design of Stop Log Gate and related equipment

The stop log shall be sturdy designed and manufactured for the expected stresses. The structure of the gate shall be made of steel to obtain high rigidity and good strength.

The stop log shall be heavy enough to overcome all friction, inertial and hydraulic forces and travel smoothly under gravity.

At the end, the weight of the stop log (including ballast if it is required) shall be 25 percent in excess of calculated forces resisting its motion. If necessary, ballast shall be firmly fixed in place to prevent movement under any circumstance including water hammer.

2.5.1 Gate Leaf

The gate leaf shall be made of steel with downstream skin plate, horizontal cross beams and vertical bracing members, bearing plates, seals, bypass valves, side guide rollers, lifting lugs and all other necessary components. The crossbeams shall carry the horizontal water load to the vertical end girders. From them the forces shall be transferred via the bearing pads to the slide tracks on the embedded structure. The gate leaf shall be arranged of minimum two (2) parts, divided in a horizontal plane. Stainless steel centering pins shall ensure an exact alignment between the gate panels.

All horizontal webs shall be drained through generously sized holes, to minimize the accumulation of debris and silt on the stop log, and maximize its clearance during lifting.

All welding seams of the gate shall be continuous to avoid corrosion points and all permanent steel joints shall be sealed by welding. Size of sealing fillet welds shall not be smaller than 3 mm.

In order to distribute the forces on the gate, main horizontal cross beams shall be properly distributed as per the water thrust.

On the upstream side of the top and bottom panel shall be stainless steel pressing wedges mounted. The wedges shall provide a definite seat of the stop log on the slide tracks.

2.5.2 Semi-automatic lifting beam

A semi-automatic lifting beam shall be provided for operation of the stop log panels. The lifting beam shall be capable of being retracted after placing the stop log panels. It shall be equipped with guide rollers and with lifting lugs to be lifted by mobile crane.

The stop log panels shall incorporate a landing sensing device, operating on the lifting beam hooks so that the hooks shall only release the stop log panel when it is on a solid landing. This is a mechanical latch to prevent accidental release. It shall avoid releasing the stop log panel if it jams in its guides for any reason whilst being lowered.

The lifting beam shall also be capable of acting the by-pass valves for filling the section between the intake stoplog and the intake roller gate.

2.5.3 Side Guides

The side guides may be sliding shoe or roller type. They shall be provided on each side on top and bottom of each stop log panel to limit lateral movement of the stop log.

The guides shall provide sufficient guiding to hold the panels into vertically piled up condition in the gate slot for expecting complete water tightness.

Roller type guides shall be provided with self-lubricating bushings and location washers. The roller pins shall be made of stainless steel. Each roller and pin as well as the necessary built-in parts shall be designed to resist the imposed load due to the stop log panel becomes jammed in the guide slot, rising (with maximum hoist capacity).

2.5.4 Bearing Pads

Bearing pads shall be foreseen to transfer the water thrust to the embedded parts. Two pads shall be included on each side of the panels.

These pads shall be made of corrosion resistant material and may be bolted onto panel structure (removable) or permanent (welded).

2.5.5 Gate Seals

Seals shall be bolted to the skin plate with full- or partial-length clamps, nuts, anti-leakage washers, ferrules and bolts all made of stainless steel.

Material and properties of the seals shall be as specified in the general technical specifications.

Seal corners shall be molded pieces, shop vulcanized to provide a single continuous seal. The tensile strength of all shop splices shall not be less than 50% of the tensile strength of the basic material.

The side seals are supposed to be of music note type and the upper seal is supposed to be of the stem type, both to be activated by the upstream water pressure, considering the water head. The bottom seal as well as the connecting seals shall be flat bar type, if necessary with a round edge.

The side and the top seals shall be coated with PTFE or comparable coating in order to reduce friction.

2.5.6 Bypass Valves

Bypass valves shall be provided in the top stop log panel for filling the space between the stop log and the roller gate.

A trash rack screen to prevent the ingress of any debris must protect the inlet to those filling valves. The lifting beam or a device proposed by the Contractor shall operate the bypass valves.

2.5.7 Storage Rack

When not in use, the stop log panels and the semi-automatic lifting beam shall be stored in storage rack. The storage rack foreseen for the panels and lifting beam will be located on the deck level 737.75 m a.s.l. in the area of the upper intake.

The storage rack for the stop log elements and the lifting beam must be of sturdy design and easy to use. The stop log elements shall be secured with a latch, which must be hinged and can be swiveled. The whole construction must be sturdy enough for any case of earthquake.

As an alternative the stop log panels and the lifting beam can be stored directly in their slot by means of connecting all panels to one stop log and hanging in the slot on a dogging device.

2.6 Embedded Parts

The embedded parts shall be of sturdy design, in order to provide the required rigidity. They shall include sill, lintel, side frames and slide tracks on the downstream face of the slots as well as pressing wedges on the upstream side, on each side at top and bottom end of the stop log.

The seal seats and sliding surfaces as well as the slide tracks and wedges shall be made of stainless steel and properly machined according to the tolerances permitted in DIN 19704. An adequate dimensioned carbon steel girder under the slide tracks shall keep the concrete pressure under the allowable values. The whole intake channel of the stop log, from sill elevation up to the lintel elevation shall be steel lined up to 300 mm downstream of the slot.

The guide rails on both sides of the stop log slots shall reach from the bottom sill elevation up to the deck elevation.

The side guides shall have enough strength to resist the load from the side rollers or shoes of each stop log panel and lifting beam in case of jamming.

All frame joints shall be doweled after assembly, and bolted together. After installation, joints must be seal welded.

All parts shall be equipped with threaded bolts and stiffeners. The threaded bolts shall be site welded to anchor plates, being encased into first stage concrete.

Anchor plates and threaded bolts shall be arranged in such a manner, that all parts to be embedded in second stage concrete are adjustable and can be rigidly fixed. Reinforcement, anchor rods and other supporting mild steel parts shall have a sufficient concrete cover. The minimum plate thickness of embedded parts shall be 15 mm.

Threaded bolts must have a minimum diameter of 16 mm. The required thread length shall be sufficient, to assure easy adjustments. The threaded bolts shall be equipped with adjusting nuts.

Supply and erection of all embedded parts as well as all studs, nuts, washers, etc., needed for the proper installation and adjustment of the second stage embedded parts, are in Contractor´s scope of works.

2.7 Shop Assembly and Test

Inspection and tests shall be made in accordance with the General Conditions, as completed and/or modified by the following specifications:

Acceptance of equipment by the Employer does not relieve Contractor from the responsibility that all equipment furnished shall be free defects and suited in all respects for the purpose intended.

The Contractor shall furnish the Employer with certified copies of shop tests.

All inspections and tests required by IEC or other local authorities shall be performed by the Contractor.

A detailed inspection plan overview will be part of the contract.

The Bidder shall submit with the proposal a preliminary Inspection and Test plan (ITP) based on his experiences. The final ITP shall be agreed in the contract negotiations.

The Contractor shall provide suitable facilities for all inspections and tests required in the functional specification, by the quality plan and for statutory purposes. Individual workshop tests for equipment shall be specified within the ITP by the Contractor during the design phase, and shall include test descriptions together with references to relevant standards according Contractors ITP.

The in-works testing of control and instrumentation equipment shall take account of the requirements given in general requirements.

2.7.1 Stop Log Gate and Embedded Parts

The stop log including seals and bearings shall be assembled in the shop in the approximate position that they shall have after installation at site. While assembling, the stop log shall be checked for dimensions, tolerances and accuracy of alignment and balancing. The seals shall be fitted to their supports during the shop assembly.

Built-in parts shall be assembled too. Sealing frames, slide tracks, side guide frames and sill beams shall be checked by straight edge and feeler gauge. All dimensions of the guide frames that correspond to the stop log dimensions shall be checked.

Parts shall be clearly match marked before disassembly for transportation and any error or misalignment discovered shall be promptly corrected.

2.8 Transportation and Installation

Transport and installation works shall be performed according general technical specification especially see chapter 10 transport and installation.

2.8.1 Embedded Parts and Built-in Parts

The embedded and built-in parts with the sealing seats and slide tracks shall be assembled in their recesses in accordance with the final approved drawings; brought to line and grade within the tolerances specified and firmly secured in place.

Alignment bolts or other necessary devices shall be used to install the guide frames at corresponding accurate position. Connections between the guide frames, anchor materials and the alignment device shall be adjustable and firmly tightened to hold the guide frames securely in position while concrete is being placed in the recesses.

Additional bracing shall be provided where necessary to ensure the required alignment. Extreme care shall be taken to ensure that the guiding, bearing and sealing surfaces lie in a true plane within the tolerances specified.

Placement of concrete in the recesses shall not proceed until the guide frames have been completely assembled and secured. During placing the concrete, alignment tolerances shall be checked and remedial action be taken if reading indicates that displacement has occurred.

2.8.2 Stop log

Each Stop log element complete with seals and side rollers or shoes shall be assembled and installed in accordance with the details shown on the final approved drawings.

Joints shall be watertight where required. The bottom of the stop log when installed shall be in correct alignment to ensure a tight and even bearing of the rubber seal on the sealing face at the sill beam or the element below.

The sides of the stop log shall be in correct alignment so the rubber seals, when installed, shall have a tight and even support on the sealing faces embedded in the concrete. The stop log shall be assembled and erected within the shop tolerance necessary to meet the specified tolerances.

2.9 Tests on Completion

After completion of the installation work at site, dry-commissioning and wet-commissioning tests shall be performed in accordance with the conditions of this specification and the general technical specifications.

The tests on completion shall consist of dry-commissioning tests and wet-commissioning tests.

2.9.1 Dry-Commissioning Tests

The dry-commissioning tests shall include, but not be limited to, the following:

- Inspection of the waterway and removal of foreign or loose objects which might cause damage
- 100% of load carrying site welds shall be tested with ultrasonic method and if the result shows discontinuities the test shall be redone with radiographic method
- Inspection of corrosion protection completion and touch ups
- Check of smooth travel inside the stop log slot
- Inspection of satisfactory sealing seat by feeler gauge measurement of all seals
- Functional check of bypass valve mechanism
- Functional check of semi-automatic lifting beam
- Functional check of storage device

2.9.2 Wet-Commissioning Tests

After satisfied that all conditions have been met, leakage and structural performance tests can be done. These tests need to be executed in coordination and in parallel with the first filling procedure of the upper reservoir, described in the owners requirements.

During filling the upper reservoir, until reaching the final water level the following checks shall be proceeded for wet commissioning tests of the stop log gate:

1. Check of water leakage on downstream (in turbine mode flow direction) side of closed stop log gate, leakage must not exceed rates specified under item 2.1.
2. Visual check of structure.
3. After reaching the final water level and approval for filling the space between the stop log and the roller gate:
4. Functional check of bypass valves, operated by the lifting beam.
5. Check of smooth travel of the stop log under balanced water pressure conditions.

2.10 Miscellaneous Metal Work

The Contractor shall provide any access ladders and platforms, handrails, cover plates, curbing, etc., related to the equipment supplied under this Contract.

The stop log slot shall be covered at deck elevation with removable gratings covered with aluminum riffle plate.

All shall be in accordance with requirements of the general technical specifications.

3 STOP LOG GATE – LOWER RESERVOIR

3.1 General

The lower reservoir intake of the Manara Project has one intake roller gate, which is the gate located closer to the pump turbine.

In order to enable maintenance-works on the roller intake gate, the Contractor has to supply one (1) set of stop log for the lower reservoir intake opening. It has to be placed in the grooves upstream (in pump mode flow direction) of the roller gate. The stop log shall be equipped with a lifting device for mobile crane operation.

The stop log panels shall be stored at deck level together with the necessary lifting device in a storage rack.

The location and general arrangement of equipment is shown in the basic design drawings.

The maximum stop log gate leakage rate at FSL shall be 0,05 l/min per meter of seal. The maximum total leakage of the closed stop log gate must not exceed 1,2 l/min.

The Contractor shall supply the stop log according to the following specification including all auxiliaries necessary for operation and maintenance.

3.2 Scope of Supply

The works under this section include the design, supply, installation, testing and commissioning of the lower reservoir intake stop log complete with all mechanical and safety equipment, spare parts and special tools.

The scope shall include, first and second stage anchor plates and embedded parts as well as any other necessary element to the proper operation of the stop log.

This scope of supply for the lower reservoir intake stop log comprises:

1. One (1) set of stop log gate

2. One (1) set of embedded and built-in parts up to elevation of deck

3. One (1) semi-automatic lifting beam for handling the stop log panels

4. One (1) storage rack for the stop log panels and the semi-automatic lifting beam

5. Spare parts as specified

3.3 Design Data

Stop log gate data	
Type of stop log	Sliding with guide wheels or sliding guide shoes
Number of stop log sets	One (1)
Number of stop log panels per set	Minimum two (2)
Clear span	3.8 m
Clear height	3.8 m
Sealing side	Downstream (in pump mode flow direction)
Skin plate side	Downstream (in pump mode flow direction)
Bottom sill level	64.68 m a.s.l.
Deck level	82.00 m a.s.l.
Maximum operation water level (FSL)	80.70 m a.s.l.
Design head	16.02 m
Operating equipment	Semi-automatic lifting beam with mobile crane
Material	EN 10025-2-S355J0
Deflection of main beam	< 1/1000 in relation to the supporting span

For material, design, manufacture and corrosion protection requirements see the corresponding clauses and annexes of the general technical specifications.

3.4 Operation Conditions

Setting and lifting of the stop log shall be done only under balanced upstream and downstream water pressure. This will be achieved by filling valves integrated in the top stop log panel and operated by the lifting device.

All stop log panels must be designed for FSL condition.

3.5 Design of Stop Log Gate and related equipment

The stop log shall be sturdy designed and manufactured for the expected stresses. The structure of the gate shall be made of steel to obtain high rigidity and good strength.

The stop log shall be heavy enough to overcome all friction, inertial and hydraulic forces and travel smoothly under gravity.

At the end, the weight of the stop log (including ballast if it is required) shall be 25 percent in excess of calculated forces resisting its motion. If necessary, ballast shall be firmly fixed in place to prevent movement under any circumstance including water hammer.

3.5.1 Gate Leaf

The gate leaf shall be made of steel with downstream (in pump mode flow direction) skin plate, horizontal cross beams and vertical bracing members, bearing plates, seals, bypass valves, side guide rollers, lifting lugs and all other necessary components. The crossbeams shall carry the horizontal water load to the vertical end girders. From them the forces shall be transferred via the bearing pads to the slide tracks on the embedded structure. The gate leaf shall be arranged of minimum two (2) parts, divided in a horizontal plane. Stainless steel centering pins shall ensure an exact alignment between the gate panels.

All horizontal webs shall be drained through generously sized holes, to minimize the accumulation of debris and silt on the stop log, and maximize its clearance during lifting.

All welding seams of the gate shall be continuous to avoid corrosion points and all permanent steel joints shall be sealed by welding. Size of sealing fillet welds shall not be smaller than 3 mm.

In order to distribute the forces on the gate, main horizontal cross beams shall be properly distributed as per the water thrust.

On the upstream (in pump mode flow direction) side of the top and bottom panel shall be stainless steel pressing wedges mounted. The wedges shall provide a definite seat of the stop log on the slide tracks.

3.5.2 Semi-automatic lifting beam

A semi-automatic lifting beam shall be provided for operation of the stop log panels. The lifting beam shall be capable of being retracted after placing the stop log panels. It shall be equipped with guide rollers and with lifting lugs to be lifted by mobile crane.

The stop log panels shall incorporate a landing sensing device, operating on the lifting beam hooks so that the hooks shall only release the stop log panel when it is on a solid landing. This is a mechanical latch to prevent accidental release. It shall avoid releasing the stop log panel if it jams in its guides for any reason whilst being lowered.

The lifting beam shall also be capable of acting the by-pass valves for filling the section between the intake stoplog and the intake roller gate.

3.5.3 Side Guides

The side guides may be sliding shoe or roller type. They shall be provided on each side on top and bottom of each stop log panel to limit lateral movement of the stop log.

The guides shall provide sufficient guiding to hold the panels into vertically piled up condition in the gate slot for expecting complete water tightness.

Roller type guides shall be provided with self-lubricating bushings and location washers. The roller pins shall be made of stainless steel. Each roller and pin as well as the necessary built-in parts shall be designed to resist the imposed load due to the stop log panel becomes jammed in the guide slot, rising (with maximum hoist capacity).

3.5.4 Bearing Pads

Bearing pads shall be foreseen to transfer the water thrust to the embedded parts. Two pads shall be included on each side of the panels.

These pads shall be made of corrosion resistant material and may be bolted onto panel structure (removable) or permanent (welded).

3.5.5 Gate Seals

Seals shall be bolted to the skin plate with full- or partial-length clamps, nuts, anti-leakage washers, ferrules and bolts all made of stainless steel.

Material and properties of the seals shall be as specified in the general technical specifications.

Seal corners shall be molded pieces, shop vulcanized to provide a single continuous seal. The tensile strength of all shop splices shall not be less than 50% of the tensile strength of the basic material.

The side seals are supposed to be of music note type and the upper seal is supposed to be of the stem type, both to be activated by the upstream (in pump mode flow direction) water pressure, considering the water head. The bottom seal as well as the connecting seals shall be flat bar type, if necessary with a round edge.

The side and the top seals shall be coated with PTFE or comparable coating in order to reduce friction.

3.5.6 Bypass Valves

Bypass valves shall be provided in the top stop log panel for filling the space between the stop log and the roller gate.

A trash rack screen to prevent the ingress of any debris must protect the inlet to those filling valves. The lifting beam or a device proposed by the Contractor shall operate the bypass valves.

3.5.7 Storage Rack

When not in use, the stop log panels and the semi-automatic lifting beam shall be stored in storage rack. The storage rack foreseen for the panels and lifting beam will be located on the deck level 82.00 m a.s.l. in the area of the upper intake.

The storage rack for the stop log elements and the lifting beam must be of sturdy design and easy to use. The stop log elements shall be secured with a latch, which must be hinged and can be swiveled. The whole construction must be sturdy enough for any case of earthquake.

As an alternative the stop log panels and the lifting beam can be stored directly in their slot by means of connecting all panels to one stop log and hanging in the slot on a dogging device.

3.6 Embedded Parts

The embedded parts shall be of sturdy design, in order to provide the required rigidity. They shall include sill, lintel, side frames and slide tracks on the downstream (in pump mode flow direction) face of the slots as well as pressing wedges on the upstream (in pump mode flow direction) side, on each side at top and bottom end of the stop log.

The seal seats and sliding surfaces as well as the slide tracks and wedges shall be made of stainless steel and properly machined according to the tolerances permitted in DIN 19704. An adequate dimensioned carbon steel girder under the slide tracks shall keep the concrete pressure under the allowable values. The whole intake channel of the stop log, from sill elevation up to the lintel elevation shall be steel lined up to 300 mm downstream of the slot.

The guide rails on both sides of the stop log slots shall reach from the bottom sill elevation up to the deck elevation.

The side guides shall have enough strength to resist the load from the side rollers or shoes of each stop log panel and lifting beam in case of jamming.

All frame joints shall be doweled after assembly, and bolted together. After installation, joints must be seal welded.

All parts shall be equipped with threaded bolts and stiffeners. The threaded bolts shall be site welded to anchor plates, being encased into first stage concrete.

Anchor plates and threaded bolts shall be arranged in such a manner, that all parts to be embedded in second stage concrete are adjustable and can be rigidly fixed. Reinforcement, anchor rods and other supporting mild steel parts shall have a sufficient concrete cover. The minimum plate thickness of embedded parts shall be 15 mm.

Threaded bolts must have a minimum diameter of 16 mm. The required thread length shall be sufficient, to assure easy adjustments. The threaded bolts shall be equipped with adjusting nuts.

Supply and erection of all embedded parts as well as all studs, nuts, washers, etc., needed for the proper installation and adjustment of the second stage embedded parts, are in Contractor´s scope of works.

3.7 Shop Assembly and Test

Inspection and tests shall be made in accordance with the General Conditions, as completed and/or modified by the following specifications:

Acceptance of equipment by the Employer does not relieve Contractor from the responsibility that all equipment furnished shall be free defects and suited in all respects for the purpose intended.

The Contractor shall furnish the Employer with certified copies of shop tests.

All inspections and tests required by IEC or other local authorities shall be performed by the Contractor.

A detailed inspection plan overview will be part of the contract.

The Bidder shall submit with the proposal a preliminary Inspection and Test plan (ITP) based on his experiences. The final ITP shall be agreed in the contract negotiations.

The Contractor shall provide suitable facilities for all inspections and tests required in the functional specification, by the quality plan and for statutory purposes. Individual workshop tests for equipment shall be specified within the ITP by the Contractor during the design phase, and shall include test descriptions together with references to relevant standards according Contractors ITP.

The in-works testing of control and instrumentation equipment shall take account of the requirements given in general requirements.

3.7.1 Stop Log Gate and Embedded Parts

The stop log including seals and bearings shall be assembled in the shop in the approximate position that they shall have after installation at site. While assembling, the stop log shall be checked for dimensions, tolerances and accuracy of alignment and balancing. The seals shall be fitted to their supports during the shop assembly.

Built-in parts shall be assembled too. Sealing frames, slide tracks, side guide frames and sill beams shall be checked by straight edge and feeler gauge. All dimensions of the guide frames that correspond to the stop log dimensions shall be checked.

Parts shall be clearly match marked before disassembly for transportation and any error or misalignment discovered shall be promptly corrected.

3.8 Transportation and Installation

Transport and installation works shall be performed according general technical specification especially see chapter 10 transport and installation.

3.8.1 Embedded Parts and Built-in Parts

The embedded and built-in parts with the sealing seats and slide tracks shall be assembled in their recesses in accordance with the final approved drawings; brought to line and grade within the tolerances specified and firmly secured in place.

Alignment bolts or other necessary devices shall be used to install the guide frames at corresponding accurate position. Connections between the guide frames, anchor materials and the alignment device shall be adjustable and firmly tightened to hold the guide frames securely in position while concrete is being placed in the recesses.

Additional bracing shall be provided where necessary to ensure the required alignment. Extreme care shall be taken to ensure that the guiding, bearing and sealing surfaces lie in a true plane within the tolerances specified.

Placement of concrete in the recesses shall not proceed until the guide frames have been completely assembled and secured. During placing the concrete, alignment tolerances shall be checked and remedial action be taken if reading indicates that displacement has occurred.

3.8.2 Stop log

Each Stop log element complete with seals and side rollers or shoes shall be assembled and installed in accordance with the details shown on the final approved drawings.

Joints shall be watertight where required. The bottom of the stop log when installed shall be in correct alignment to ensure a tight and even bearing of the rubber seal on the sealing face at the sill beam or the element below.

The sides of the stop log shall be in correct alignment so the rubber seals, when installed, shall have a tight and even support on the sealing faces embedded in the concrete. The stop log shall be assembled and erected within the shop tolerance necessary to meet the specified tolerances.

3.9 Tests on Completion

After completion of the installation work at site, dry-commissioning and wet-commissioning tests shall be performed in accordance with the conditions of this specification and the general technical specifications.

The tests on completion shall consist of dry-commissioning tests and wet-commissioning tests.

3.9.1 Dry-Commissioning Tests

The dry-commissioning tests shall include, but not be limited to, the following:

- Inspection of the waterway and removal of foreign or loose objects which might cause damage
- 100% of load carrying site welds shall be tested with ultrasonic method and if the result shows discontinuities the test shall be redone with radiographic method
- Inspection of corrosion protection completion and touch ups
- Check of smooth travel inside the stop log slot
- Inspection of satisfactory sealing seat by feeler gauge measurement of all seals
- Functional check of bypass valve mechanism
- Functional check of semi-automatic lifting beam
- Functional check of storage device

3.9.2 Wet-Commissioning Tests

After satisfied that all conditions have been met, leakage and structural performance tests can be done. These tests need to be executed in coordination and in parallel with the first filling procedure of the lower reservoir, described in the owners requirements.

During filling the lower reservoir, until reaching the final water level the following checks shall be proceeded for wet commissioning tests of the stop log gate:

1. Check of water leakage on downstream (in pump mode flow direction) side of closed stop log gate, leakage must not exceed rates specified under item 2.1.
2. Visual check of structure.
3. After reaching the final water level and approval for filling the space between the stop log and the roller gate.
4. Functional check of bypass valves, operated by the lifting beam.
5. Check of smooth travel of the stop log under balanced water pressure conditions.

3.10 Miscellaneous Metal Work

The Contractor shall provide any access ladders and platforms, handrails, cover plates, curbing, etc., related to the equipment supplied under this Contract.

The stop log slot shall be covered at deck elevation with removable gratings covered with aluminum riffle plate.

All shall be in accordance with requirements of the general technical specifications.

4 ROLLER INTAKE GATE – UPPER RESERVOIR

4.1 General

The Manara Project has one (1) emergency roller intake gate at the upper reservoir located in a vertical shaft, which shall be capable to shut off the water flow against the double maximum turbine discharge independently to external power supply.

The gate closer to the pump-turbine is the roller gate. It shall be equipped with a hydraulic cylinder complete with cylinder support and ancillaries to be operated by an oil-hydraulic power unit located inside the cylinder chamber inside the intake structure.

The roller gate is installed to close the water way to the pump-turbine unit in case of pressure loss in the penstock, failure of the main inlet valve, triggering by the flood protection system, maintenance works on the pressure shaft and main inlet valve or earthquake conditions or in normal operation case.

The maximum roller gate leakage rate at FSL shall be 0,05 l/min per meter of seal. The maximum total leakage of the closed roller gate must not exceed 1,2 l/min.

The location and general arrangement of gates and ancillary equipment are shown in the basic design drawings.

The Contractor shall supply the roller gate according to the following specification including all auxiliaries necessary for operation and maintenance.

4.2 Scope of Supply

The works under this section include the design, supply, installation, testing and commissioning of the intake roller gate complete with all mechanical, electrical, control and safety equipment and spare parts and special tools.

The scope shall include, first and second stage anchor plates and embedded parts as well as any other necessary element to the proper operation of the gate.

This scope of supply comprises for the roller intake gate of the upper reservoir:

- One (1) roller gate
- One (1) set of embedded and built-in parts for the gate up to deck elevation, including dogging device
- One (1) water tight cover
- One (1) set of hydraulic hoisting equipment including hydraulic power unit (HPU)
- One (1) set of position indicators
- One (1) control equipment

4.3 Design Data

The gates shall be designed according to DIN 19704 or equivalent and for the following conditions:

Roller Gate Data	
Type of gate	Roller gate
Number of gates	One (1)
Clear span	3.8 m
Clear height	3.8 m
Sealing side – gate upper reservoir	Upstream
Skin plate side – gate upper reservoir	Upstream
Design flow	76 m^3/s
Emergency closure function	Yes
Sill level	700.33 m a.s.l.
Deck level	737.75 m a.s.l.
Maximum operation water level (FSL)	737.00 m a.s.l.
Design head	36.67 m
Operating equipment	Hydraulic hoist
Hydraulic cylinder support level	711.33 m a.s.l.
Material	EN 10025-2-S355J0
Deflection of main beam	< 1/1000 in relation to the supporting span

The roller intake gate shall operate primarily in automatic mode. In addition an emergency hand operation shall be implemented to open or close the valve manually from the hydraulic power unit.

For material, design, manufacture and corrosion protection requirements see the corresponding clauses and annexes of the general technical specifications.

4.4 Operation Conditions

The intake roller gate for the upper reservoir will be designed to close under maximum flow in turbine mode and being opened a few centimeters under unbalanced condition with water pressure from the upper reservoir for filling the downstream waterway.

Normally the gate will be hanging in guard position inside the gate shaft and will be operated for maintenance purposes under balanced pressure condition. It shall be operated from the local control board (LCB) and from the remote control as well.

In an emergency situation, if downstream equipment or installations have to be protected, the gates shall be closed by the control system or by emergency push button from the main control room (MCR). Emergency closure of the gate must be possible independent to external power supply, only by the gates dead load. The effective operating force shall be 20% above the value determined when all relevant dead loads, frictions and hydraulic loads are considered.

As an extreme condition it shall be considered the possibility of a simultaneous closure of the gate while the turbine governor is closing too. This situation may produce a counter pressure on the gate.

During pump operation of the pump turbine measures must to be taken to prevent the roller intake gate from closing and keeping the gate in its open position inside the gate shaft.

4.5 Design of Roller Gate and related equipment

The gate shall be sturdy designed and manufactured for the expected stresses of emergency operation included water hammer. The structure of the gate shall be made of steel to obtain high rigidity and good strength.

Special attention shall be paid to the possible uplift effect of the gate. If necessary the gate shall be properly ballasted to prevent accidents. A detail calculation shall be provided by the contractor to support its design and for determining the gate driving forces.

4.5.1 Gate Leaf

The gate leaf shall be made of steel with upstream skin plate, horizontal beams and vertical bracing members, bearing plates, seals, main and side rollers, lifting lugs and all other necessary components. Alternative orientation of the skinplate on downstream side is a matter of Employers approval. The horizontal beams shall carry the horizontal water load to the end vertical girders. From them the forces shall be transferred via the wheel axes, bearings and wheels to the embedded structures. The gate leaf shall be arranged of minimum two (2) parts, divided in a horizontal plane and connected via bolts.

Rigid vertical beams shall be arranged on both sides of the gate structure in order to bear the moments introduced by the axes of the wheels. Preferably wheels shall not be assembled of the cantilever type.

All horizontal webs shall be drained through generously sized holes, to minimize the accumulation of debris and silt on the gate, and maximize its clearance during lifting.

In order to distribute the forces on the gate, main cross beams shall be properly distributed as per the water thrust.

The bottom edge of the roller gate shall be shaped for low vibration while lowering the gate in running water or under full load.

All welding seams of the gate shall be continuous to avoid corrosion points and all permanent steel joints shall be sealed by welding. The size of sealing fillet welds shall not be smaller than 3 mm.

The piston rod or of the hydraulic cylinder must be connected to the gate leaf by spherical bearing and stainless steel pin. That pin shall be easy to be removed by the operating personnel when handling the lifting link. Threaded holes for extraction, special devices and tools shall be foreseen for that purpose.

4.5.2 Wheel Assembly

Wheels shall be of forged or cast stainless steel, and they shall be fitted with bearings of the spherical roller type. They shall be efficiently sealed to exclude dirt, moisture and water under all operation conditions.

The axes shall be made of stainless steel. Since more than two wheels will be used per side of each gate, they shall be adjustable. Articulated connection or eccentric shafts may allow adjustments in order to distribute the force equally over the wheels. The roller bearings shall be spherical type to allow gate deflection. Additionally upstream counter guide rails for the wheels as well as side guide rollers shall be provided in the embedded guide beams to prevent wheel misalignment.

The bearings shall be selected considering an axial load of 10% of the maximum radial load on the wheel and following the manufacturer recommendations. The lifetime shall be selected in accordance with 50 year service.

The support area of the wheels provided with fixed axes shall ensure that the pressure between the wheel and the rail bearing surface is within the limits stated in DIN 19704. The Hertzian stresses must be checked in this respect and the hardness penetration shall be carefully assured.

4.5.3 Gate Seals

The gate seals shall be bolted to the skin plate with full- or partial-length clamps, nuts, washers, ferrules and bolts all made of stainless steel. Ferrules shall ensure constant clamping of the seal against the clamping bars.

Material and properties of the seals shall be as specified in the general technical specifications.

Seal corners shall be molded pieces, shop vulcanized to provide a single continuous seal. The tensile strength of all shop splices shall not be less than 50% of the tensile strength of the basic material.

Lateral seals are supposed to be of the music note type and the top seal is supposed to be from the stem type, both shape activated by the upstream water pressure, considering the water head. The bottom seal as well as the connecting seals are supposed to be of the flat bar type if necessary with round edge.

The side and the top seals shall be coated with PTFE or comparable coating in order to reduce friction.

4.5.4 Gate instrumentation

In general the gate shall be equipped with following instruments for monitoring, control, and protection:

- Analog position indicator consisting of a sturdy vertical sliding stainless steel rod with scale for direct reading the gate leaf position
- Limit switches for gate position mounted on the stainless steel rod (closed, opened, filling position)
- Analog position indicator (4 – 20 mA)
- Pressure switches in the gate hydraulic actuating system
- Pressure measurement equipment in the intake channel (reservoir side and penstock side)
- Differential pressure measurement equipment
- Various limit switches for monitoring and interlocking

The switches shall be used to relay information to the control panel, to control the operation of the hydraulic pump and in conjunction with pressure switches in the hydraulic system, to trigger the alarm signal "gate is stuck".

4.5.5 Differential pressure measurement system

A differential pressure measurement system shall be installed in order to determine if the pressure is equalized for opening the gate.

4.5.6 Watertight cover on the gate shaft

An watertight cover, consisting of multiple-parts removable parts and embedded steel lining shall be foreseen on top of the gate shaft at elevation 711.33 masl. This cover shall contain sealed bushings for the hydraulic cylinder rod and the position indicator rod. To gain the necessary tightness of the cover it will be necessary to machine the flanges of the cover parts and the shaft lining. In addition to the fastening screws, threaded holes for removing the cover shall be foreseen.

Beside the watertight cover a manhole down to the gate shaft is foreseen in the slab. Also this manhole shall be steel lined and covered with a watertight cover. The steel lining, the cover itself as well as necessary sealings and bolts shall be in scope of supply of the intake roller gate. If possible the manhole can also be integrated in the cover on the gate shaft.

The gate shall be driven by a hydraulic cylinder, located in the cylinder chamber above the gate shaft as shown on the basic design drawings. That cylinder shall be mounted on the watertight cover. Therefore it shall also be designed to carry the operation loads of the gate, seismic loads etc.

4.5.7 Auxiliary Lifting Equipment

Provisions shall be made and delivered to lift out the gates for maintenance purposes. The design has to guarantee easy and save removal during lifting in and lifting out. Lifting lugs, threaded holes and special devices and tools shall be foreseen and delivered for the gate extraction and reinstallation.

4.5.8 Ladders and platforms

To safely reach the gate shaft which is located below deck level of the cylinder chamber and further down gate shaft and the bottom sill, sufficient ladders and necessary platforms need to be delivered.

4.6 Hydraulic hoist

The hydraulic cylinders and the controls must be designed to properly “open” and “close” the gate as above described. Provisions shall be made to recover the gate position in case it sinks because of malfunctioning or leakages in the hydraulic system.

The actuator and its hydraulic system shall be designed to close the gate fail safe and designed in accordance with the requested standards.

4.6.1 Oil Hydraulic Cylinder

The cylinder shall be designed in accordance with DIN 19704 and the general technical specifications. The connection with the gate shall be articulated by a spherical bearing. Cylinder rods shall be made of stainless steel chromium platted. Ceramic-coated cylinder rods are also acceptable.

The required operating forces shall be 20% above the values determined when all relevant dead loads, frictions and hydraulic loads are considered.

All bolts, washers and nuts used in the hydraulic actuator equipment shall be properly corrosion protected as per the ambient conditions.

4.6.2 Oil Hydraulic Power Unit

The oil hydraulic unit shall be designed in accordance with DIN 19704 and the general technical specifications. The hydraulic power unit shall be provided as one unit located in the operation building.

The unit shall be equipped with two (2) pumps driven by AC motor, each one capable to operate the gate at a maximum normal operating pressure as given in DIN 19704. One of the AC motor driven pumps shall be back-up to operate the gate if the other operation pump fails. The hydraulic power unit shall be placed in an oil tray which has the minimum capacity to collect the whole oil amount of the oil reservoir.

The hydraulic power unit and the LCB shall be located in the cylinder chamber.

The oil pumps shall be located on the top of the oil reservoir and be arranged for easy maintenance and properly identified.

The unit shall be provided with all required hydraulic and electric devices to guarantee reliable and safe operation. Following equipment shall be included, but not be limited to:

- Relief valves
- Limit switches
- Pressure gauges
- High and low oil pressure alarm switches
- Alarm switches
- Protective relays
- Emergency operation hand pump

The first filling with hydraulic fluid shall be included in this scope.

4.6.3 Hydraulic Pressure Piping

The Contractor shall supply all necessary hydraulic piping. Pipe hangers and necessary hardware shall be included as well.

Piping and socket welded fittings of stainless steel shall be used throughout the oil system according to DIN 19704.

4.7 Electrical and Control Equipment

The complete local control system required to operate the intake gates and auxiliaries has to be furnished under this Contract. Gate control shall be possible from the LCB and the MCR as well.

Remote control shall be supplied and the LCB with all instruments/components needed for that remote control.

The equipment must contain a programmable logic controller (PLC), integrated in the LCB and shall be selected in accordance with the general technical specifications, electrical equipment.

4.7.1 Equipment

The LCB shall be an outdoor, self-standing type of steel plate construction having hinged front cover with lock, and the main equipment to be mounted inside and on the operating board shall be at least:

- Molded case circuit breakers
- Miniature circuit breakers
- Contactors and relays
- Protective relays for motors
- Voltmeter and ammeters
- Valve control equipment

- A LOCAL/REMOTE control selector switch. This switch shall be key-operated, with the key only being removable when the switch is in the 'remote' position.
- Emergency stop lock button for maintenance purposes and manual operation
- Push-buttons and indicating lamps for local control of the gate
- Continuous gate position indicator (0 - 100%)
- Gate position indicator lamps (opened, filling position, closed)
- Indicating lamps for the different alarms
- Terminal interface to the gate and the main control room (MCR)
- Signals and alarms shall also be transmitted to the MCR
- All terminal blocks and other equipment necessary to complete the control system

4.7.2 Control Operation

Local control shall be available from the LCB located in the cylinder chamber. It shall allow the operator to open or close the gate. This control panel shall be foreseen watertight and properly protected against ambient working conditions and floods.

Each gate control panel shall be provided with an emergency stop push-button, which shall be hard-wired to over-ride all other gate controls.

If the gates are selected for 'local' control at its control panel, all gate control shall be by push buttons on the LCB. 'Local' control shall be hard-wired and completely independent of the programmable logic controller such that it remains operable in case of any failure of the PLC. 'Local' control will normally be used for maintenance when the intake stop log is set.

If the gates are selected for 'remote' it shall be controlled via the main plant control system.

4.7.3 Main Control System

The Contractor shall supply all required signal interfaces with the main plant control system. The Contractor shall supply and install the relevant cables and interfaces.

4.7.4 Controls, Alarms and Indications

The Contractor shall provide the controls, alarms and indications contained in the following schedule. Some deviation from these requirements may be permitted if this is appropriate for the equipment being provided.

Description	Type	Signal	Location
Intake Roller Gate			
Control mode, remote/local	control	control selector	LCB/MCR
	indication	status	LCB/MCR
Gate open/stop/close	control	pushbuttons/ keyboard	LCB/MCR
Gate opening/stopped/closing	indication	lamps	LCB/MCR
Emergency stop	control	pushbutton	LCB
	indication	status	LCB/ MCR
Gate fully closed	indication	lamp/status	LCB/ MCR
Gate fully opened	indication	lamp/status	LCB/ MCR
Gate opened in filling position	indication	lamp/status	LCB/ MCR
Gate position	indication	status	LCB/ MCR
Gate travel time exceeded	alarm	status	MCR
Gate control faulty	alarm	status, grouping of * below	MCR
Gate HPU motor power supply failed *	alarm	lamp/status	LCB
Gate control power supply failed *	alarm	lamp/status	LCB
Gate HPU motor overload operated *	alarm	lamp/status	LCB
Gate control circuit breaker tripped *	alarm	lamp/status	LCB
Gate HPU system fault *	alarm	lamp/status	LCB/ MCR
HPU oil pressure low *	alarm	lamp/status	LCB
HPU oil pressure high *	alarm	lamp/status	LCB
Gate hoist excess pressure *	alarm	lamp/status	LCB
Gate excess travel *	alarm	lamp/status	LCB
Power supplies healthy	indication	lamp	LCB
Gate hoist oil pressure	indication	gauge	LCB
Sump oil level	indication	gauge/status	LCB/ MCR
Oil filter blocked	indication	flag	LCB/ MCR

LCB = Local Control Board MCR = Main Control Room

4.8 Embedded Parts

The Contractor shall provide the complete sealing frames on the upstream side. That frame shall consist of sill and lintel beams, and side frames, all with a stainless steel seal seat. Both lateral sealing frames shall extend from the sill elevation not less than twice the gate height.

The Contractor shall also provide the complete track beams on the downstream side. Both rails shall extend from the sill elevation not less than twice the gate height.

Furthermore lateral guide beams shall be provided from the sill elevation to the deck elevation inside the gate shaft.

The seal seats and sliding surfaces as well as the wheel rolling surfaces shall be made of stainless steel and properly machined according to the tolerances permitted in DIN 19704. An adequate dimensioned carbon steel girder under the wheel rolling surface shall keep the concrete pressure under the allowable values.

All joints between parts shall be equipped with bolts, dowels and anchor plates.

At deck elevation the embedded parts shall also include a dogging device, for the case of maintenance on the hydraulic hoist. This dogging device shall be of sturdy design to bear the whole gate assembly in order to be able to dismantle the hydraulic hoisting equipment.

The threaded bolts will be welded at site to anchor plates, being encased into first stage concrete.

Anchor plates and threaded bolts shall be arranged in such a manner, that all parts to be embedded in second stage concrete are adjustable and can be rigidly fixed. Reinforcement, anchor rods and other supporting mild steel parts must have a sufficient concrete cover. The minimum plate thickness of embedded parts shall be 15 mm.

Threaded bolts must have a minimum diameter of 16 mm. The required thread length shall be sufficient, to assure easy adjustments. The threaded bolts shall be equipped with adjusting nuts.

Supply and erection of all embedded parts as well as all studs, nuts, washers, etc., needed for the proper installation and adjustment of the second stage embedded parts, are in Contractor´s scope of works.

4.9 Shop Assembly and Test

Inspection and tests shall be made in accordance with the General Conditions, as completed and/or modified by the following specifications:

Acceptance of equipment by the Employer does not relieve Contractor from the responsibility that all equipment furnished shall be free defects and suited in all respects for the purpose intended.

The Contractor shall furnish the Employer with certified copies of shop tests.

All inspections and tests required by IEC or other local authorities shall be performed by the Contractor.

A detailed inspection plan overview will be part of the contract.

The Bidder shall submit with the proposal a preliminary Inspection and Test plan (ITP) based on his experiences. The final ITP shall be agreed in the contract negotiations.

The Contractor shall provide suitable facilities for all inspections and tests required in the functional specification, by the quality plan and for statutory purposes. Individual workshop tests for equipment shall be specified within the ITP by the Contractor during the design phase, and shall include test descriptions together with references to relevant standards according Contractors ITP.

The in-works testing of control and instrumentation equipment shall take account of the requirements given in general requirements.

4.9.1 Roller Gate and Embedded Parts

The intake gate including seals, wheels and bearings shall be assembled in the shop in the approximate position that it shall have after installation at site. While assembling, the gate shall be checked for dimensions, tolerances and accuracy of alignment and balancing. The seals shall be fitted to their supports during the shop assembly.

Built-in parts shall be assembled too. Sealing frames, track frames, side guide frames and sill beams shall be checked by means of straight edge and feeler gauge. All dimensions of the guide frames that correspond to the gate dimensions shall be checked.

Parts shall be clearly match marked before disassembly for transportation and any error or misalignment discovered shall be promptly corrected.

4.9.2 Hydraulic Actuator and Hydraulic Power Unit

The hydraulic actuator and the hydraulic oil unit shall be completely assembled in the shop and pressure-tested according to DIN 19704 and the general technical specifications to ensure all parts are sound and that all parts fit and operate properly.

The oil to be used for the test shall be new, clean light hydraulic oil. Special care shall be taken not to introduce harmful foreign matters such as dirt, chips, water, etc., into the hydraulic system before, during or after the test.

The following items, at least, shall be checked during the shop operation test:

- Operation speed
- Voltage and current of electric motor
- Oil pressure in hydraulic unit

- Temperature raise of bearings, motor and oil pump
- Existence of noise and vibration
- Operation of limit switches
- Measurement of oil leakage past the piston rod
- Oil level low
- Accuracy of position indicator
- Manual operation of oil pump equipment
- Condition of control cabinets, including alarm signal, etc.

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

4.10 Transport and Installation

Transport and installation works shall be performed according general technical specification especially see chapter 10 transport and installation.

4.10.1 Guide Frames

The lateral and sill frames shall be assembled in their recesses in accordance with the final approved drawings, brought to line and grade within the tolerances specified and firmly secured in place.

Alignment bolts or other necessary device shall be used to install the built-in parts in accurate position. Connections between the built-in parts, anchor materials and the alignment device shall be adjustable and firmly tightened to hold the frames securely in position while concrete is being placed in the recesses.

Additional bracing shall be provided where necessary to ensure the required alignment. Extreme care shall be taken to ensure that the guide, bearing and sealing surfaces lie in a true plane within the tolerances specified.

Placement of concrete in the recesses shall not proceed until the built-in parts have been completely assembled and secured. During encasing the concrete, alignment tolerances shall be checked and remedial action taken if reading indicates that displacement has occurred.

4.10.2 Roller Gate

The gate complete with rollers, seals and ancillaries shall be assembled and erected in accordance with the details shown on the final approved drawings.

Joints shall be watertight where required. The bottom of the gate when erected shall be in true alignment to ensure a tight and even bearing of the rubber seal on the sealing face at the sill beam. The sides of the gate shall be in true alignment so that

the rubber seals, when installed, shall have a tight and even support on the sealing faces. The gate shall be assembled and erected to meet the specified tolerances.

4.10.3 Hydraulic Actuator and Hydraulic Power Unit

The hydraulic actuator and hydraulic power unit shall be assembled and installed in accordance with the final approved drawings.

During installation of the actuator, hydraulic power unit and connection piping, special care shall be taken to prevent the entrance of dirt, chips, piping compound and other foreign matters into the hydraulic systems. Before connecting the actuator to the gate, the installed servomotors with hydraulic unit shall be repeatedly flushed several times in order to remove foreign materials from the oil circuits and to check their correct function and operation.

After confirmation of the correct operation of the hydraulic actuator by the trial operation, the hydraulic actuator shall be connected to the gate and then operation test of the gate shall be performed. The absence of any oil leakage shall be confirmed during the shop test. Any defect or improper operation discovered during the test shall be fixed the entire test shall be repeated to the satisfaction of the Contractor.

4.11 Tests on Completion

After completion of the installation work at site, dry-commissioning and wet-commissioning tests shall be performed in accordance with the conditions of this specification and the general technical specifications.

The tests on completion shall consist of dry-commissioning tests and wet-commissioning tests.

4.11.1 Dry-Commissioning Tests

Dry commissioning shall include, but not be limited to the following:

- Inspection of the waterway and removal of foreign or loose objects which might cause damage
- 100% of load carrying site welds shall be tested with ultrasonic method and if the result shows discontinuities the test shall be redone with radiographic method
- Inspection of corrosion protection completion and touch ups
- Insulation resistance tests on all site installed wiring and electrical connections
- Calibration of scale for gate opening
- Operation of HPU, automatic and manually-operated starting and stopping devices and signaling devices and motors power consumption

- Oil level and pressure in HPU; condition of oil filters
- Check of accuracy of indication, limit setting and alarm signals from LCB/MCR (oil level, oil temperature, travel, pressure)
- Temperature raise of motors, oil, etc.
- Times for opening and closing of the roller gate
- Check of travel limits
- Bearing clearance for gate wheels
- Inspection of satisfactory sealing seat by feeler gauge measurement of all seals
- Proper fastening of the manhole in the cylinder chamber

4.11.2 Wet-Commissioning Tests

After satisfied that all conditions have been met, leakage and structural performance tests can be done. These tests need to be executed in coordination with the first filling procedure of the upper reservoir, described in the owners requirements.

When the first interim level during filling the upper reservoir is reached the following sequence shall be proceeded for wet commissioning static tests of the roller gate:

1. Setting the upstream stop log
2. Lowering of water level in the high pressure shaft below the intake sill elevation
3. Closing the roller gate via LCB
4. Controlled filling the intake channel upstream the roller gate via the stop log by-pass valve
5. Check of water leakage on downstream side of closed gate, leakage must not exceed rates specified under item 4.1
6. Balancing of water pressure by filling of downstream waterway via small opening of the gate to the filling position
7. Opening and closing the gate under balanced conditions via LCB and remote controlled from the MCR

This procedure shall be conducted for two interim levels and finally for the FSL while filling the upper reservoir. Each interim level will be maintained for four days according to the owners requirements. Within these four days the wet commissioning tests on the intake gate shall be executed.

After completion of above described static tests at FSL, the emergency closure of the roller gate under maximum flow in turbine mode shall be tested during pump turbine commissioning.

A detailed commissioning procedure shall be submitted by the Contractor.

4.12 Miscellaneous Metal Work

The Contractor shall provide any access ladders and platforms, handrails, cover plates, curbing, etc., related to the equipment supplied under this Contract.

The ceiling above the roller gates has to be water tight. The gates actuator, also the manhole and all pipe and cable penetrations has to be water tight as well.

All shall be in accordance with requirements of the general technical specifications.

5 ROLLER INTAKE GATE – LOWER RESERVOIR

5.1 General

The Manara Project has one (1) emergency roller intake gate at the lower reservoir located in a vertical shaft, which shall be capable to shut off the water flow at maximum pump discharge independently to external power supply.

The gate closer to the pump-turbine is the roller gate. It shall be equipped with a hydraulic cylinder complete with cylinder support and ancillaries to be operated by an oil-hydraulic power unit located inside the cylinder chamber inside the intake structure.

The roller gate is installed to close the water way to the pump-turbine unit in case of triggering by the flood protection system, uncontrolled outflow of water into the power cavern, failure of the draft tube flap gate, maintenance works on the draft tube flap gate and main inlet valve or earthquake conditions.

The maximum roller gate leakage rate at FSL shall be 0,05 l/min per meter of seal. The maximum total leakage of the closed roller gate must not exceed 1,2 l/min.

The location and general arrangement of gates and ancillary equipment are shown in the basic design drawings.

The Contractor shall supply the roller gate according to the following specification including all auxiliaries necessary for operation and maintenance.

5.2 Scope of Supply

The works under this section include the design, supply, installation, testing and commissioning of the intake roller gate complete with all mechanical, electrical, control and safety equipment and spare parts and special tools.

The scope shall include, first and second stage anchor plates and embedded parts as well as any other necessary element to the proper operation of the gate.

This scope of supply comprises for the roller intake gate of the lower reservoir:

- One (1) roller gate with integrated relief flaps against headwater pressure
- One (1) set of automatic hydraulically actuated interlocking which prohibits the gate closing while the main inlet valves are not closed
- One (1) set of embedded and built-in parts for the gate up to deck elevation, including dogging device
- One (1) water tight cover
- One (1) set of hydraulic hoisting equipment including hydraulic power unit (HPU)
- One (1) set of position indicators
- One (1) control equipment

5.3 Design Data

The gates shall be designed according to DIN 19704 or equivalent and for the following conditions:

Roller Gate Data	
Type of gate	Roller gate
Number of gates	One (1)
Clear span	3.8 m
Clear height	3.8 m
Sealing side – gate lower reservoir	Upstream in pump mode flow direction
Skin plate side – gate lower reservoir	Upstream in pump mode flow direction
Design flow	32 m³/s
Emergency closure function	Yes
Sill level	64.68 m a.s.l.
Deck level	82.00 m a.s.l.
Maximum operation water level (FSL)	80.70 m a.s.l.
Design head	16.02 m
Operating equipment	Hydraulic hoist
Hydraulic cylinder support level	82.00 m a.s.l.
Material	EN 10025-2-S355J0
Deflection of main beam	< 1/1000 in relation to the supporting span

The roller intake gate shall operate primarily in automatic mode. In addition an emergency hand operation shall be implemented to open or close the valve manually from the hydraulic power unit.

For material, design, manufacture and corrosion protection requirements see the corresponding clauses and annexes of the general technical specifications.

5.4 Operation Conditions

The intake roller gate for the lower reservoir will be designed to close under maximum flow in pump mode and being opened a few centimeters under unbalanced condition with water pressure from the lower reservoir for filling the low pressure waterway.

Normally the gate will be hanging in guard position inside the gate shaft and will be operated for maintenance purposes under balanced pressure condition. It shall be operated from the local control board (LCB) and from the remote control as well.

In an emergency situation, if downstream equipment or installations have to be protected, the gates shall be closed by the control system or by emergency push button from the main control room (MCR). Emergency closure of the gate must be possible independent to external power supply, only by the gates dead load. The effective operating force shall be 20% above the value determined when all relevant dead loads, frictions and hydraulic loads are considered.

In closed position the gate must be protected against water pressure from headwater side with relief flaps integrated in the gate body.

While the gate is hanging in its guard position inside the gate shaft measures must to be taken to prevent closing of the gate until the main inlet valves are not closed.

5.5 Design of Roller Gate and related equipment

The gate shall be sturdy designed and manufactured for the expected stresses of emergency operation included water hammer. The structure of the gate shall be made of steel to obtain high rigidity and good strength.

Special attention shall be paid to the possible uplift effect of the gate. If necessary the gate shall be properly ballasted to prevent accidents. A detail calculation shall be provided by the contractor to support its design and for determining the gate driving forces.

5.5.1 Gate Leaf

The gate leaf shall be made of steel with upstream (in pump mode flow direction) skin plate, horizontal beams and vertical bracing members, bearing plates, seals, main and side rollers, lifting lugs and all other necessary components. Alternative orientation of the skinplate on downstream side is a matter of Employers approval. The horizontal beams shall carry the horizontal water load to the end vertical girders. From them the forces shall be transferred via the wheel axes, bearings and wheels to the embedded structures. The gate leaf shall be arranged of minimum two (2) parts, divided in a horizontal plane and connected via bolts.

Rigid vertical beams shall be arranged on both sides of the gate structure in order to bear the moments introduced by the axes of the wheels. Preferably wheels shall not be assembled of the cantilever type.

All horizontal webs shall be drained through generously sized holes, to minimize the accumulation of debris and silt on the gate, and maximize its clearance during lifting.

In order to distribute the forces on the gate, main horizontal cross beams shall be properly distributed as per the water thrust.

The bottom edge of the roller gate shall be shaped for low vibration while lowering the gate in running water or under full load.

All welding seams of the gate shall be continuous to avoid corrosion points and all permanent steel joints shall be sealed by welding. The size of sealing fillet welds shall not be smaller than 3 mm.

The piston rod or of the hydraulic cylinder must be connected to the gate leaf by spherical bearing and stainless steel pin. That pin shall be easy to be removed by the operating personnel when handling the lifting link. Threaded holes for extraction, special devices and tools shall be foreseen for that purpose.

5.5.2 Wheel Assembly

Wheels shall be of forged or cast stainless steel, and they shall be fitted with bearings of the spherical roller type. They shall be efficiently sealed to exclude dirt, moisture and water under all operation conditions.

The axes shall be made of stainless steel. Since more than two wheels will be used per side of each gate, they shall be adjustable. Articulated connection or eccentric shafts may allow adjustments in order to distribute the force equally over the wheels. The roller bearings shall be spherical type to allow gate deflection. Additionally upstream counter guide rails for the wheels as well as side guide rollers shall be provided in the embedded guide beams to prevent wheel misalignment.

The bearings shall be selected considering an axial load of 10% of the maximum radial load on the wheel and following the manufacturer recommendations. The lifetime shall be selected in accordance with 50 year service

The support area of the wheels provided with fixed axes shall ensure that the pressure between the wheel and the rail bearing surface is within the limits stated in DIN 19704. The Hertzian stresses must be checked in this respect and the hardness penetration shall be carefully assured.

5.5.3 Gate Seals

The gate seals shall be bolted to the skin plate with full- or partial-length clamps, nuts, washers, ferrules and bolts all made of stainless steel. Ferrules shall ensure constant clamping of the seal against the clamping bars.

Material and properties of the seals shall be as specified in the general technical specifications.

Seal corners shall be molded pieces, shop vulcanized to provide a single continuous seal. The tensile strength of all shop splices shall not be less than 50% of the tensile strength of the basic material.

Lateral seals are supposed to be of the music note type and the top seal is supposed to be from the stem type, both shape activated by the upstream water pressure, considering the water head. The bottom seal as well as the connecting seals are supposed to be of the flat bar type if necessary with round edge.

The side and the top seals shall be coated with PTFE or comparable coating in order to reduce friction.

5.5.4 Gate instrumentation

In general the gate shall be equipped with following instruments for monitoring, control, and protection:

- Analog position indicator consisting of a sturdy vertical sliding stainless steel rod with scale for direct reading the gate leaf position
- Limit switches for gate position mounted on the stainless steel rod (closed, opened, filling position)
- Analog position indicator (4 – 20 mA)
- Pressure switches in the gate hydraulic actuating system
- Pressure measurement equipment in the intake channel (reservoir side and penstock side)
- Differential pressure measurement equipment
- Various limit switches for monitoring and interlocking

The switches shall be used to relay information to the control panel, to control the operation of the hydraulic pump and in conjunction with pressure switches in the hydraulic system, to trigger the alarm signal "gate is stuck".

5.5.5 Differential pressure measurement system

A differential pressure measurement system shall be installed in order to determine if the pressure is equalized for opening the gate.

5.5.6 Cylinder support beam

The gate shall be driven by a hydraulic cylinder, located in the cylinder chamber at deck level 82.00 m a.s.l. above the gate shaft as shown on the basic design drawings. That cylinder shall be mounted on a steel base frame especially designed to carry the operation loads of the gate, seismic loads etc. The steel base frame shall be spanned over the opening in the bottom slab of the deck level. For maintenance reasons it shall be possible to easily remove the steel base frame. In terms of fall protection, open spaces between the opening in the slab and the cylinder support beams shall be covered with gratings.

5.5.7 Auxiliary Lifting Equipment

Provisions shall be made and delivered to lift out the gates for maintenance purposes. The design has to guarantee easy and save removal during lifting in and lifting out. Lifting lugs, threaded holes and special devices and tools shall be foreseen and delivered for the gate extraction and reinstallation.

5.5.8 Ladders and platforms

To safely reach the gate shaft which is located below deck level of the cylinder chamber and further down gate shaft and the bottom sill, sufficient ladders and necessary platforms need to be delivered.

5.6 Hydraulic hoist

The hydraulic cylinders and the controls must be designed to properly “open” and “close” the gate as above described. Provisions shall be made to recover the gate position in case it sinks because of malfunctioning or leakages in the hydraulic system.

The actuator and its hydraulic system shall be designed to close the gate fail safe and designed in accordance with the requested standards.

5.6.1 Oil Hydraulic Cylinder

The cylinder shall be designed in accordance with DIN 19704 and the general technical specifications. The connection with the gate shall be articulated by a spherical bearing. Cylinder rods shall be made of stainless steel chromium platted. Ceramic-coated cylinder rods are also acceptable.

The required operating forces shall be 20% above the values determined when all relevant dead loads, frictions and hydraulic loads are considered.

All bolts, washers and nuts used in the hydraulic actuator equipment shall be properly corrosion protected as per the ambient conditions.

5.6.2 Oil Hydraulic Power Unit

The oil hydraulic unit shall be designed in accordance with DIN 19704 and the general technical specifications. The hydraulic power unit shall be provided as one unit located in the operation building.

The unit shall be equipped with two (2) pumps driven by AC motor, each one capable to operate the gate at a maximum normal operating pressure as given in DIN 19704. One of the AC motor driven pumps shall be back-up to operate the gate if the other operation pump fails. The hydraulic power unit shall be placed in an oil tray which has the minimum capacity to collect the whole oil amount of the oil reservoir.

The hydraulic power unit and the LCB shall be located in the cylinder chamber.

The oil pumps shall be located on the top of the oil reservoir and be arranged for easy maintenance and properly identified.

The unit shall be provided with all required hydraulic and electric devices to guarantee reliable and safe operation. Following equipment shall be included, but not be limited to:

- Relief valves
- Limit switches
- Pressure gauges
- High and low oil pressure alarm switches
- Alarm switches
- Protective relays

- Emergency operation hand pump

The first filling with hydraulic fluid shall be included in this scope.

5.6.3 Hydraulic Pressure Piping

The Contractor shall supply all necessary hydraulic piping. Pipe hangers and necessary hardware shall be included as well.

Piping and socket welded fittings of stainless steel shall be used throughout the oil system according to DIN 19704.

5.7 Electrical and Control Equipment

The complete local control system required to operate the intake gates and auxiliaries has to be furnished under this Contract. Gate control shall be possible from the LCB and the MCR as well.

Remote control shall be supplied and the LCB with all instruments/components needed for that remote control.

The equipment must contain a programmable logic control (PLC), integrated in the LCB and shall be selected in accordance with the general technical specifications, electrical equipment.

5.7.1 Equipment

The LCB shall be an outdoor, self-standing type of steel plate construction having hinged front cover with lock, and the main equipment to be mounted inside and on the operating board shall be at least:

- Molded case circuit breakers
- Miniature circuit breakers
- Contactors and relays
- Protective relays for motors
- Voltmeter and ammeters
- Valve control equipment
- A LOCAL/REMOTE control selector switch. This switch shall be key-operated, with the key only being removable when the switch is in the ’remote’ position.
- Emergency stop lock button for maintenance purposes and manual operation
- Push-buttons and indicating lamps for local control of the gate
- Continuous gate position indicator (0 - 100%)
- Gate position indicator lamps (opened, filling position, closed)
- Indicating lamps for the different alarms

- Terminal interface to the gate and the main control room (MCR)
- Signals and alarms shall also be transmitted to the MCR
- All terminal blocks and other equipment necessary to complete the control system

5.7.2 Control Operation

Local control shall be available from the LCB located in the cylinder chamber. It shall allow the operator to open or close the gate. This control panel shall be foreseen watertight and properly protected against ambient working conditions and floods.

Each gate control panel shall be provided with an emergency stop push-button, which shall be hard-wired to over-ride all other gate controls.

If the gates are selected for 'local' control at its control panel, all gate control shall be by push buttons on the LCB. 'Local' control shall be hard-wired and completely independent of the programmable logic controller such that it remains operable in case of any failure of the PLC. 'Local' control will normally be used for maintenance when the intake stop log is set.

If the gates are selected for 'remote' it shall be controlled via the main plant control system.

5.7.3 Main Control System

The Contractor shall supply all required signal interfaces with the main plant control system. The Contractor shall supply and install the relevant cables and interfaces.

5.7.4 Controls, Alarms and Indications

The Contractor shall provide the controls, alarms and indications contained in the following schedule. Some deviation from these requirements may be permitted if this is appropriate for the equipment being provided.

Description	Type	Signal	Location
Intake Roller Gate			
Control mode, remote/local	control	control selector	LCB/MCR
	indication	status	LCB/MCR
Gate open/stop/close	control	pushbuttons/ keyboard	LCB/MCR
Gate opening/stopped/closing	indication	lamps	LCB/MCR
Emergency stop	control	pushbutton	LCB
	indication	status	LCB/ MCR
Gate fully closed	indication	lamp/status	LCB/ MCR
Gate fully opened	indication	lamp/status	LCB/ MCR
Gate opened in filling position	indication	lamp/status	LCB/ MCR

Gate position	indication	status	LCB/ MCR
Gate travel time exceeded	alarm	status	MCR
Gate control faulty	alarm	status, grouping of * below	MCR
Gate HPU motor power supply failed *	alarm	lamp/status	LCB
Gate control power supply failed *	alarm	lamp/status	LCB
Gate HPU motor overload operated *	alarm	lamp/status	LCB
Gate control circuit breaker tripped *	alarm	lamp/status	LCB
Gate HPU system fault *	alarm	lamp/status	LCB/ MCR
HPU oil pressure low *	alarm	lamp/status	LCB
HPU oil pressure high *	alarm	lamp/status	LCB
Gate hoist excess pressure *	alarm	lamp/status	LCB
Gate excess travel *	alarm	lamp/status	LCB
Power supplies healthy	indication	lamp	LCB
Gate hoist oil pressure	indication	gauge	LCB
Sump oil level	indication	gauge/status	LCB/ MCR
Oil filter blocked	indication	flag	LCB/ MCR

LCB = Local Control Board MCR = Main Control Room

5.8 Embedded Parts

The Contractor shall provide the complete sealing frames on the upstream side (in pump mode flow direction). That frame shall consist of sill and lintel beams, and side frames, all with a stainless steel seal seat. Both lateral sealing frames shall extend from the sill elevation not less than twice the gate height.

The Contractor shall also provide the complete track beams on the downstream side. Both rails shall extend from the sill elevation not less than twice the gate height.

Furthermore lateral guide beams shall be provided from the sill elevation to the deck elevation inside the gate shaft.

The seal seats and sliding surfaces as well as the wheel rolling surfaces shall be made of stainless steel and properly machined according to the tolerances permitted in DIN 19704. An adequate dimensioned carbon steel girder under the wheel rolling surface shall keep the concrete pressure under the allowable values.

All joints between parts shall be equipped with bolts, dowels and anchor plates.

At deck elevation the embedded parts shall also include a dogging device, for the case of maintenance on the hydraulic hoist. This dogging device shall be of sturdy design to bear the whole gate assembly in order to be able to dismantle the hydraulic hoisting equipment.

The threaded bolts will be welded at site to anchor plates, being encased into first stage concrete.

Anchor plates and threaded bolts shall be arranged in such a manner, that all parts to be embedded in second stage concrete are adjustable and can be rigidly fixed. Reinforcement, anchor rods and other supporting mild steel parts must have a sufficient concrete cover. The minimum plate thickness of embedded parts shall be 15 mm.

Threaded bolts must have a minimum diameter of 16 mm. The required thread length shall be sufficient, to assure easy adjustments. The threaded bolts shall be equipped with adjusting nuts.

Supply and erection of all embedded parts as well as all studs, nuts, washers, etc., needed for the proper installation and adjustment of the second stage embedded parts, are in Contractor´s scope of works.

5.9 Shop Assembly and Test

Inspection and tests shall be made in accordance with the General Conditions, as completed and/or modified by the following specifications:

Acceptance of equipment by the Employer does not relieve Contractor from the responsibility that all equipment furnished shall be free defects and suited in all respects for the purpose intended.

The Contractor shall furnish the Employer with certified copies of shop tests.

All inspections and tests required by IEC or other local authorities shall be performed by the Contractor.

A detailed inspection plan overview will be part of the contract.

The Bidder shall submit with the proposal a preliminary Inspection and Test plan (ITP) based on his experiences. The final ITP shall be agreed in the contract negotiations.

The Contractor shall provide suitable facilities for all inspections and tests required in the functional specification, by the quality plan and for statutory purposes. Individual workshop tests for equipment shall be specified within the ITP by the Contractor during the design phase, and shall include test descriptions together with references to relevant standards according Contractors ITP.

The in-works testing of control and instrumentation equipment shall take account of the requirements given in general requirements.

5.9.1 Roller Gate and Embedded Parts

The intake gate including seals, wheels and bearings shall be assembled in the shop in the approximate position that it shall have after installation at site. While assembling, the gate shall be checked for dimensions, tolerances and accuracy of alignment and balancing. The seals shall be fitted to their supports during the shop assembly.

Built-in parts shall be assembled too. Sealing frames, track frames, side guide frames and sill beams shall be checked by means of straight edge and feeler gauge. All dimensions of the guide frames that correspond to the gate dimensions shall be checked.

Parts shall be clearly match marked before disassembly for transportation and any error or misalignment discovered shall be promptly corrected.

5.9.2 Hydraulic Actuator and Hydraulic Power Unit

The hydraulic actuator and the hydraulic oil unit shall be completely assembled in the shop and pressure-tested according to DIN 19704 and the general technical specifications to ensure all parts are sound and that all parts fit and operate properly.

The oil to be used for the test shall be new, clean light hydraulic oil. Special care shall be taken not to introduce harmful foreign matters such as dirt, chips, water, etc., into the hydraulic system before, during or after the test.

The following items, at least, shall be checked during the shop operation test:

- Operation speed
- Voltage and current of electric motor
- Oil pressure in hydraulic unit
- Temperature raise of bearings, motor and oil pump
- Existence of noise and vibration
- Operation of limit switches
- Measurement of oil leakage past the piston rod
- Oil level low
- Accuracy of position indicator
- Manual operation of oil pump equipment
- Condition of control cabinets, including alarm signal, etc.

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

5.10 Transport and Installation

Transport and installation works shall be performed according general technical specification especially see chapter 10 transport and installation.

5.10.1 Guide Frames

The lateral and sill frames shall be assembled in their recesses in accordance with the final approved drawings, brought to line and grade within the tolerances specified and firmly secured in place.

Alignment bolts or other necessary device shall be used to install the built-in parts in accurate position. Connections between the built-in parts, anchor materials and the alignment device shall be adjustable and firmly tightened to hold the frames securely in position while concrete is being placed in the recesses.

Additional bracing shall be provided where necessary to ensure the required alignment. Extreme care shall be taken to ensure that the guide, bearing and sealing surfaces lie in a true plane within the tolerances specified.

Placement of concrete in the recesses shall not proceed until the built-in parts have been completely assembled and secured. During encasing the concrete, alignment tolerances shall be checked and remedial action taken if reading indicates that displacement has occurred.

5.10.2 Roller Gate

The gate complete with rollers, seals and ancillaries shall be assembled and erected in accordance with the details shown on the final approved drawings.

Joints shall be watertight where required. The bottom of the gate when erected shall be in true alignment to ensure a tight and even bearing of the rubber seal on the sealing face at the sill beam. The sides of the gate shall be in true alignment so that the rubber seals, when installed, shall have a tight and even support on the sealing faces. The gate shall be assembled and erected to meet the specified tolerances.

5.10.3 Hydraulic Actuator and Hydraulic Power Unit

The hydraulic actuator and hydraulic power unit shall be assembled and installed in accordance with the final approved drawings.

During installation of the actuator, hydraulic power unit and connection piping, special care shall be taken to prevent the entrance of dirt, chips, piping compound and other foreign matters into the hydraulic systems. Before connecting the actuator to the gate, the installed servomotors with hydraulic unit shall be repeatedly flushed several times in order to remove foreign materials from the oil circuits and to check their correct function and operation.

After confirmation of the correct operation of the hydraulic actuator by the trial operation, the hydraulic actuator shall be connected to the gate and then operation test of the gate shall be performed. The absence of any oil leakage shall be

confirmed during the shop test. Any defect or improper operation discovered during the test shall be fixed the entire test shall be repeated to the satisfaction of the Contractor.

5.11 Tests on Completion

After completion of the installation work at site, dry-commissioning and wet-commissioning tests shall be performed in accordance with the conditions of this specification and the general technical specifications.

The tests on completion shall consist of dry-commissioning tests and wet-commissioning tests.

5.11.1 Dry-Commissioning Tests

Dry commissioning shall include, but not be limited to the following:

- Inspection of the waterway and removal of foreign or loose objects which might cause damage
- 100% of load carrying site welds shall be tested with ultrasonic method and if the result shows discontinuities the test shall be redone with radiographic method
- Inspection of corrosion protection completion and touch ups
- Insulation resistance tests on all site installed wiring and electrical connections
- Calibration of scale for gate opening
- Operation of HPU, automatic and manually-operated starting and stopping devices and signaling devices and motors power consumption
- Oil level and pressure in HPU; condition of oil filters
- Check of accuracy of indication, limit setting and alarm signals from LCB/MCR (oil level, oil temperature, travel, pressure)
- Temperature raise of motors, oil, etc.
- Times for opening and closing of the roller gate
- Check of travel limits
- Bearing clearance for gate wheels
- Inspection of satisfactory sealing seat by feeler gauge measurement of all seals
- Proper fastening of the manhole in the cylinder chamber

5.11.2 Wet-Commissioning Tests

After satisfied that all conditions have been met, leakage and structural performance tests can be done. These tests need to be executed in coordination with the first filling procedure of the upper reservoir, described in the owners requirements.

When the first interim level during filling the upper reservoir is reached the following sequence shall be proceeded for wet commissioning static tests of the roller gate:

1. Setting the upstream (in pump mode flow direction) stop log

2. Closing the roller gate via LCB

3. Filling the lower reservoir in accordance to the owners requirements

4. Controlled filling the intake channel upstream (in pump mode flow direction) the roller gate via the stop log by-pass valve

5. Check of water leakage on downstream side of closed gate, leakage must not exceed rates specified under item 5.1.

6. Balancing of water pressure by filling of downstream waterway via small opening of the gate to the filling position. For this step the commissioning of the pump turbine and its up and downstream waterways must be finished.

7. Opening and closing the gate under balanced conditions via LCB and remote controlled from the MCR

This procedure shall be conducted for two interim levels and finally for the FSL while filling the lower reservoir. Each interim level will be maintained for four days according to the owners requirements. Within these four days the wet commissioning tests on the intake gate shall be executed.

After completion of above described static tests at FSL, the emergency closure of the roller gate shall be tested during pump turbine commissioning.

A detailed commissioning procedure shall be submitted by the Contractor.

5.12 Miscellaneous Metal Work

The Contractor shall provide any access ladders and platforms, handrails, cover plates, curbing, etc., related to the equipment supplied under this Contract.

All shall be in accordance with requirements of the general technical specifications.

6 SPARE PARTS, TOOLS AND CONSUMABLES

The requirements are defined in the General Technical Specifications for all the entire E&M and H&M equipment.