

VOLUME-2
PART- I
Section-4
Main Inlet Valve with
Accessories

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4. Main Inlet Valve with Accessories

4.1 Scope of Work

The intent of these specifications is to define the scope of work under this section which covers the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage & preservation, installation, commissioning, performance testing, acceptance testing, training of Purchaser's personnel, handing over to Purchaser and guarantee of main inlet valves of butterfly type along with accessories for Keyi Hydroelectric Project, Arunachal Pradesh, as per the specifications hereunder, each complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

It is not the intention to specify the minute details/smallest items to deliver a functional system or to define the standard manufacturing practice but to outline the performance, constructional, operational and guaranteed requirements. It is the responsibility of the contractor to ensure these requirements.

4.2 Scope of Supply

The scope of work shall be a comprehensive functional system complete in every respect including but not be limited to following:

4.2.1 Material

4.2.1.1 Main Inlet Valve

Two (2) sets of 1.4m dia. or suitable for turbine inlet requirement subject to approval during detailed engineering diameter turbine main inlet valves of the butterfly type assembly complete in all respects comprising of valve bodies, disc, trunnion and counterweights together with bearings, service seal and appurtenances each comprising of

- One (1) set of embedded and foundation parts
- One (1) set of hydraulic operating mechanisms each consisting of one/two single acting servomotors, including cylinders and necessary mechanical linkages
- One (1) set of by-pass assemblies with, piping, hydraulically operated valve, guard valve and control equipment
- One (1) set of upstream extension pieces with penstock drain valve and make up piece for connection to penstock
- One (1) set of downstream extension pieces with spiral case drain valve
- One (1) set control systems including console, electro-hydraulic control, sensing and indicating devices, control piping, and devices for local and remote indication
- Oil for first filling of all components with 10% extra quantity, in non-returnable drums, for all two (2) units.

- One (1) set of special handling devices and fixtures for inlet valve components
- Coordination and provision of necessary contacts and/or ports for integration with plant SCADA system
- Spare parts
- Special tools and instruments for inspection, dismantling and reassembly of elements of supply

4.2.2 Scope of Services

- Transportation and delivery to site including all logistics and proper site storage and preservation as per manufacturer's recommendation.
- Site installation and commissioning
- Field / touch-up painting including all painting materials
- Performance and field acceptance testing as per the relevant clause of this section and submission of report
- Training of Purchaser's personnel including operation and maintenance staff
- All the technical documentation including preparation and submission of O & M manuals

Any other item(s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard(s) / best international practices.

4.3 Design and Layout Conditions

4.3.1 Layout arrangement

The main inlet valve (MIV) shall be used to connect and shut-off penstock during normal unit start-up, shutdown respectively and to permit de-watering of the turbines. The valve shall also be used to shut-off turbine flows in case of governor failure.

The design of the valves shall be such as to resist the hydraulic forces acting directly on the body and disc under all possible conditions. When fully open, the valves shall provide minimum obstruction to flow of water. In the closed position, the valves shall be leak tight.

The main inlet valves shall be suitable to be handled by the Powerhouse EOT cranes and the design & dimensioning of the valves shall be such that each assembled valve can be handled (lifting and lowering) by these EOT cranes.

4.3.2 Limit of supply

The main inlet valve shall be furnished with suitable flanged extension pipe of required length so as to have welded connection to the penstock on upstream side, and bolted connection with the upstream side of the inlet valve. The extension pipe shall have necessary make up allowance to take care of any mismatching between penstock and inlet valve.

The main inlet valve shall also be furnished with flanged removable extension pipe of required length with a sleeve type coupling for connection to the turbine spiral case on the downstream side.

4.3.3 Operating conditions

Depending upon operating requirements, the valves shall be either fully open or fully closed and no partial opening of the valve is envisaged. The opening and closing of the valves shall be hydraulically operated by the valve servomotors by means of a high pressure oil system and counter weights respectively.

The valves shall be capable of closing against maximum head, including water hammer for maximum turbine discharge at all operating conditions including runaway with normal working stress on all parts.

During opening operation, the valve is to be opened by using oil pressure and for reliable closing; the valve shall be capable of closing by counter weights.

The Contractor shall ensure that that the counter weight closing mechanism shall not result in extra dimensioning of the valve house / powerhouse.

All valves and their operating mechanism, extensions, coupling and related bypass, sealing and drain system shall withstand safely the maximum stresses from the following operating conditions, with stresses in the materials not exceeding the maximum allowable stress as per clause "Maximum Allowable Stresses" of "Section 1 - General Information and Requirements":

- Continuous operation with MIV in the open position passing the maximum discharge of 11.275 m³/s of the turbine while operating at 100% guide vane opening and at a net head of 125.48 m.
- Operation with MIV in open position withstanding the total maximum water pressure of 16.5 bars on the valve centre line, which includes the design pressure rise allowance.
- Operation with MIV in closed position withstanding the total maximum water pressure of 16.5 bars.
- During flow stopping of MIV in case of governor failure while operating under the above mentioned discharge and maximum water pressure.

4.3.4 Special design considerations

Following points shall be taken in to consideration while designing the main inlet valves:

- The valves shall have split jointed body if required due to shipping limitations, double seal and two double/single acting servomotors.
- Disc shall be single section (Lattice type through flow)
- The closing of the valve at maximal flow rate and full one side pressure shall also be possible by action of counter weights.
- By-pass valve shall be designed for closure against maximum possible flow rate under maximum gross head.
- The axial forces shall be transmitted over the upstream pipe into the concrete.
- Own weight and mass of water shall be transmitted by the valve feet into the ground.

4.4 Rating and Functional Characteristics

4.4.1 Standards

Unless otherwise stated, rating, characteristics, test and test procedures, etc. shall comply with the provisions and requirements of the latest applicable International / Indian Standards.

4.4.2 Technical data and description of equipment

Purpose of valve	Main Inlet Valve
Number of valves	2
Type	Butterfly valve lattice door construction with split jointed body, if required, due to shipping limitation
Nominal diameter	1.4m
Penstock / pressure shaft diameter	1.6 m
Seals	Service seal
Maximum static head	130.85 m
Maximum water pressure (due to water hammer)	16.5 bars
Hydrostatic Test pressure (on valve body)	24.75 bars
Opening and closing time	Adjustable between 60 and 90 seconds
Minimum shut off discharge	1.3xQrated

4.4.3 Water Conductor System

The details of the water conductor system feeding the generating units and various levels are given in Turbine specification.

4.5 Performance Criteria and Guarantee

The valves along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. It is the responsibility of the Contractor to supply the equipment as per guaranteed technical particulars and shall also guarantee the reliability and performance.

4.5.1 Leakage

The Contractor shall guarantee the maximum leakage through the main inlet valve service maintenance seals under maximum gross head. The Contractor shall also guarantee the maximum leakage of the by-pass valve under maximum gross head. The leakage shall not exceed the leakage limits specified in IS: 7326.

4.5.2 Maximum head loss

The Contractor shall guarantee the maximum head loss for main inlet valves at maximum flow passing through the valve under any operating head.

4.6 Design and Construction

4.6.1 Standards

The system and equipment shall be designed, built, tested and installed to the latest revisions of the following applicable standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed engineering for the purpose:

Standard	Description
IS 7326	Turbine inlet butterfly valves for hydropower stations and system

4.6.2 Design stress limits

The design stress limit shall be as per clause "Maximum Allowable Stresses" of "Section 1 - General Information and Requirements".

4.6.3 Material selection and standards

The material specifications and their standards for major components of main inlet valves shall be as shown below. The material grade and classification wherever specified are obligatory and proposed equivalent national/international standard for the same shall only be considered if their chemical composition, mechanical properties, manufacturing methods are similar/superior and are suitable for proposed use. The Contractor shall establish the equivalence/superiority for acceptance by the Purchaser.

1. VALVE BODY	Fabricated S355J2+N/P355N(1.0562) EN10025/ Equivalent G20Mn5/216 WCB/WCC
2. VALVE BODY BOSSES	Forged S355J2+N/Cast G20Mn5/216 WCB/WCC
3. VALVE BODY SEAT RING	AISI 304/AISI 316
4. VALVE DISC	Fabricated S355J2+N/P355N(1.0562) EN10025/ Equivalent
5. TRUNNIONS	Forged X20Cr13(1.4021)/AISI-420/Equivalent

6. DISC SEAL CLAMP RING	AISI 304/AISI 316
7. OPERATING LEVER	S355J2+N /P355N(1.0562)/ Equivalent
8. TRUNNION BEARINGS	DEVA/ DU GGB GLACIER
9. SERVOMOTOR	Covers & Tube S355J2/St52-3/ Equivalent Rod C40/C45, Seals Trelleborg/Hunger
10. COUNTERWEIGHT	STEEL/CAST IRON
11. INLET PIPE	S355J2+N /P355N(1.0562)/ Equivalent EN 10025
12. OUTLET PIPE	S355J2+N/P355N EN 10025/Equivalent
13. BYPASS PIPING	ASTMA 106-B/S355J2/Equivalent
14. BYPASS NEEDLE VALVE	Needle Valve Body X20Cr13+QT/AISI 420+QT Sleeve/Piston X3CrNiMo13-4(1.4313).

Note: -

The main inlet valve design and construction shall be such that when worn, the working seals shall be capable of being replaced without having to dismantle the main valves. The complete method and sequence of replacing the working seals shall be furnished by the Bidders in their bids comprising explanatory write ups, sketches, drawings. Further dewatering of the pressure shaft upstream of the maintenance seal shall not be essential for the replacement of the working seals.

4.6.4 Valve body

4.6.4.1 General

The valve body shall be in single/two pieces, made of welded plate steel, or of cast steel, or a combination of both, bolted together by hydraulically pre-stressed bolts. It shall be of rigid construction and adequately ribbed as necessary to minimize distortion under full load and maximum pressure and designed to transmit the hydraulic thrust to the upstream valve body extension and penstock. The trunion bearing housings shall be integral with the valve body and supported by it. The valve body shall be provided with flanges for bolted connections to similar flanges on the valve body extensions. The valve body shall be machined only after it has been subjected to stress-relieving heat treatment.

The valve body shall be designed to avoid any abrupt changes in velocity. Water passage may be so shaped so as to give either constant velocity or gradual increase in velocity in the direction of flow. Minimum loss of head shall be kept in view while designing.

4.6.4.2 Foundation

The concrete foundation shall be designed and provided by the civil contractor in the first stage concrete. The Contractor shall design the necessary anchoring to the concrete structure, for most severe load conditions. The valve body shall be provided with integral supporting feet designed for transmitting the full load, including the weight of the flanged extensions and contained water, servomotor thrust to base plates secured in the concrete pedestals. The necessary base or sole plates complete with anchor bolts shall be furnished.

4.6.4.3 Valve Disc

The valve disc shall be made of cast steel in one piece, or of welded plate steel construction, or a combination of both, ruggedly designed and heavily ribbed internally to minimize deflection under load in the closed position. The disc shall be single section.

The main inlet valve disc shall be double seal flow through lattice type. The discs shall be designed to ensure smooth water flow, with low head loss and withstand full differential pressure across the closed valve. The valve disc shall not cause any abnormal vibrations during full opening & closing operation or transmit fluttering and shall be leak tight / not cause water leakage more than the prescribed limits. The head loss across the valve shall be stated and guaranteed by the supplier. The design geometry of valve disc along with pressure drop/head loss characteristic should be based on model studies carried out for similar type of valves. Angular travel of the disc shall be nearly ninety (90) degrees from shut off to open position.

Mechanical locking to lock the valve in close/open position shall be provided. The flow passage shall be such that any head losses and flow disturbances can be reduced to a minimum. The disc shall be machined at its rim and provided with an approved stainless steel seal seat and replaceable/ repairable type rubber seal as service seal.

The surfaces of both the seals in contact with the disc, flange and body shall be plated with stainless steel overlay of minimum 3mm thick.

4.6.4.4 Trunnions

The trunnions shall be made of forged steel. The trunnion bearing and seal surfaces shall be provided with replaceable stainless steel sleeves or suitable corrosion resistant overlay not less than 3 mm thick. Appropriate seals shall be provided at the outside ends of the trunnions to prevent leakage. The design and construction of the seals shall be based on a recognized design giving due regard to dependability, long life, and convenient replacement.

4.6.4.5 Main bearings

The main bearings shall be of the sleeve type, supported integrally within the valve body. The bearings shall be designed and constructed so that all necessary adjustments may be made from outside the bearing housings. The sleeve bearings shall be of corrosion resisting material and shall be designed so that deflection and trunnion slope caused by the water load on the disc in the closed position shall not result in binding between the trunnions and sleeves. The bearing shall be built into the valve body and shall transmit the loads to body. The bearings of either side shall be interchangeable.

The Contractor shall determine from his own experience the most suitable bearing design. The Contractor shall submit his design to the Engineer for approval.

4.6.4.6 Valve seals and seats

The main inlet valve body and disc shall be machined to accommodate the valve seals. The valve shall be provided with robust movable seals. The movable seal rings shall be designed to slide in and out of contact with the adjacent seat rings.

The material for service seal shall be nitrile rubber.

The sealing surface shall be so designed /constructed that there is no jamming when water is drained from the generating unit after closure under full head and there is minimum damage on the seat and the seal.

The service seal adjustment feature may be accomplished either in the seal retaining elements or in the seal seating element from the downstream side of the valve. It shall be possible to adjust and replace the service seal with the inlet valve closed

The seat, seal retainers and fasteners shall be of 13Cr-4Ni stainless steel. The seals and the seats shall be designed and constructed of such material that they shall provide maximum tightness, maximum resistance to the silt, minimum maintenance, minimum leakage, convenient adjustment and replacement.

4.6.4.7 Permissible leakage

The maximum permissible leakage from service seal of MIV shall not exceed three (3) litres per minute.

Maximum permissible leakage from the maintenance seal of MIV shall not exceed six (6) lpm

4.6.5 Flanged extensions and erection joints

4.6.5.1 General

The valves shall be furnished with two valve body extensions, one for the inlet side of the valve and another for the outlet side. A sleeve type coupling (not transmitting any axial loads) shall be provided for connecting the outlet extension pipe to the pressure shaft in case of PV / turbine spiral case in case of MIV. The extensions shall be of plate steel construction, designed for withstanding specified hydrostatic test pressure.

All necessary nuts, bolts and gaskets for the flanged connection between the valve body and the extensions shall be furnished by the Contractor. No special supports shall be provided for the extensions. Their weight, including contained water shall be carried through the flanged joints to the valve body.

4.6.5.2 Upstream connection

The valve body inlet extension shall be provided with bolting flanges at one end for connection to the valve body. Extra length to accommodate any variations in the distance between penstock and valve

flange for connecting the inlet extension to the valve body shall also be included in scope of supply. The connections of the extension to the penstock shall be of welded type. The Contractor shall cut, chamfer and weld together the end of the penstock and the valve extension including all necessary NDT or heat treatment.

The material of the penstock / pressure shaft shall be ASTM - A537 Class -1.

The flanged connection with necessary guard valve for by pass valve, penstock drainage valve shall be in the scope of contractor, necessary tapped /plugged connection for differential gauge to measure the losses shall also be provided.

The following connections shall be provided on the upstream pipe of main inlet valve

- One for by-pass valve
- One for butterfly valve control
- One for emptying the penstock /pressure shaft
- Tapping for discharge / flow measurement and pressure gauges / transducers

4.6.5.3 Downstream connection

An extension pipe with sleeve type coupling (not transmitting any axial load) of an approved type shall be furnished to connect the valve to spiral inlet pipe. The coupling shall allow the valve to be displaced 15 mm along the penstock axis due to hydraulic forces and thermal expansion/contraction to facilitate erection and dismantling of the extension pipe for replacement of the inlet valve seal and to allow for any small differences in distributor extension length. The extension pipe shall be complete with all necessary steel flanges, seals or gaskets and coupling bolts. The thickness of this piece shall be as per the thickness of spiral case.

The surfaces of the coupling in contact with the seal and the seal groove shall be plated with stainless steel.

The following connections shall be provided on the downstream pipe:-

- One for by-pass valve connection
- Tapping for pressure gauges / transducers
- One for emptying the scroll case / pressure shaft

4.6.6 By-pass assembly

A by-pass assembly complete with hydraulically operated valve, piping and necessary electrical controls, hand-operated guard valve upstream of the by-pass valve and piping, designed for specified operating pressure shall be provided. The opening and closing of the valve shall be controlled by hydraulic pressure from the oil pressure unit.

By-pass valve shall be designed for closure against maximum possible flow rate under maximum gross head.

The by-pass valves shall be of cast or forged steel with wearing parts of corrosion resisting material. A hand wheel mechanism for manual operation of by-pass valve shall also be provided.

The by-pass valve of penstock shall be used for filling the pressure shaft and equalizing the pressure across penstock. The by-pass valve of MIV shall be used for filling the turbine spiral casing and equalizing the pressure across the main inlet valve disc before opening.

"Open", "intermediate", "close" limit switches, each with two electrically independent contacts, shall be provided as required to accomplish the specified control and alarm functions of penstock & MIVs.

By-pass pipe line shall be properly clamped /secured to avoid any vibration during operation.

A suitable differential pressure switch should be provided which will provide a signal for the valve to open once the pressure on both upstream and downstream of the valve is equalized. Pressure equalizing device and differential pressure switch shall be interlocked with valve control to preclude valve opening signal before the pressure equalization.

4.6.6.1 Pressure gauge

A duplex pressure gauge and differential pressure switch of potential free contacts shall be provided for showing the difference between the water pressure upstream and downstream of the valve disc.

4.6.6.2 Piping

The by-pass piping shall be of seamless steel pipe with steel flanged connections. The necessary bolts, nuts and gaskets shall be furnished by the Contractor to make the system complete.

4.6.7 Valves

4.6.7.1 Penstock and spiral drainage system

The penstock upstream of MIV including penstock upstream shall be drained through turbine up to tail water level. In order to evacuate the remaining quantity of water, a penstock drainage system shall be installed.

A similar drain outlet should be provided for complete dewatering of the spiral case through draft tube.

Both the drain outlets shall have heavy removable cast steel grating, studs and nuts, cast or forged steel body gate type drain valve with all necessary fittings and piping.

The pressure rating of the valves shall be similar to MIV.

4.6.7.2 Valve operating mechanism

The butterfly valves (MIV) operating mechanism shall consist of servomotor with base plate and anchor bolts and connecting linkage for opening. The closing of the valves shall be accomplished through counter weight. The lever shall be made of steel and shall be keyed to the valve trunnion. The operating mechanism shall have sufficient capacity to move the valve disc smoothly through one full opening.

The operating mechanism shall include suitable positive stops to limit the disc travel at the fully opened and fully-closed positions. A mechanical position/proximity switch indicating device shall be provided on the operating mechanism to indicate the position of the valve disc.

Provision shall be made at both sides of the operating mechanism to manually lock the butterfly valves in the closed position. Individual lock shall be capable of holding the butterfly valves in the closed position against full combined force of both the servomotors. Parts with sliding contact shall have self-lubricating bushings and corrosion resistant shafts with surface finish and coating as required.

All pilot and control valves, limit switches and interlocks necessary to coordinate the operation of the lock with the main butterfly valves and bypass valves' sequence of operation shall be provided. When the valve is locked in the closed position, the electric circuits for opening the valve shall be inoperative. Provision shall also be made for padlocking the locking device when in the closed position. The locking device shall be so designed that it cannot be locked when the main valve is in the open position.

The supply shall include the hydraulic control system complete with the necessary valves, piping, fitting and filters etc. for the operation.

Oil pressure connection to the hydraulic cylinder shall be by means of rigid piping to flexible joints on the cylinder. Oil pressure supply shall be from the respective oil pressure unit which is common for governor as well as for main inlet valve.

4.6.7.3 Servomotor

The servomotor cylinder body shall be made of forged steel or cast steel, or welded plate steel and shall be accurately bored to receive the piston. The servomotor shall be provided with suitable gaskets or seal rings designed to remain oil tight at maximum operating pressure.

The operating cylinders shall be sized to open the valve with minimum system oil pressure. The closing of the valve shall be arranged exclusively through counterweight without any aid from pressure oil system.

The piston rod connecting the piston to the operating lever linkage shall be hardened, corrosion resistant and chromium plated steel. The pistons shall be provided with approved type packing and metal piston rings suitable for the required oil pressure service.

4.6.7.4 Counter weight

The counterweights shall be sized to provide net closing torque on the valve rotor under all possible operating conditions and shall be of fabricated steel/cast steel.

4.6.8 Oil pressure system

4.6.8.1 General

Each generating unit shall have a common oil pressure system for operation of the main inlet valve and governing system. The construction, design and operation details of oil pressure system for MIV shall be same as specified under governing system.

The design shall be compact, and there shall be easy access to all the components for maintenance and replacement. All the components shall be selected to assure high reliability, long life, low noise and minimum heating of the oil.

4.6.8.2 Operating pressure

The normal operating pressure of the hydraulic oil pressure system for all the butterfly valves shall be within 60-120 bars. It shall be same as that of Turbine governor OPU. The operating pressure range shall be manufacturers' standard for the proposed application and shall have proved satisfactory for similar valves which have been in operation.

High pressure for oil pressure system shall be achieved through high pressure nitrogen /compressed air accumulators as specified under governing system.

4.6.9 Miscellaneous Components

4.6.9.1 Lifting and Handling Fixtures

The Contractor shall provide lifting fixtures and special tackles and devices for handling of major components of main inlet valve like valve body, disc, transition sections, servomotors, counterweight, bearings etc. These devices shall include at least the following:

- One (1) valve handling and lifting device for handling and lifting the assembly of valve in-situ,
- One (1) valve disc lifting device and special nylon slings for lifting and handling the valve disc, servomotors, levers, counterweight etc.

4.6.9.2 Name Plate

A rating nameplate of stainless steel material shall be attached to each major and auxiliary item of equipment supplied. This plate shall be permanently engraved with the designed full load ratings, serial number, type number, date of manufacture and other identification deemed necessary. Hydraulic and electric control system diagram plates shall also be supplied. The material and the identifying inscription shall be approved by the Employer.

4.6.10 Auxiliary system

4.6.10.1 Lubrication system

All bearings and trunnion seals shall be provided with greaseless self lubricated system. The details of lubrication arrangement provided shall be described in the bid.

4.6.10.2 Oil and water piping

Oil piping shall be heavy seamless, stainless steel pipes and shall include all piping to the oil pressure supply system consisting of sump tank, pressure tank, servomotor, cabinet instrumentation etc. as required. The piping shall be of such size that the maximum oil velocity shall not exceed 3.0 m/sec in the pressure lines and 1.5 m/sec in the return lines.

The entire piping system shall be welded, insofar as practicable, leaving only such flanged connections as may be necessary for erection or possible subsequent dismantling for repair. Whenever straight pipes are provided, tapered flanged connections shall be introduced to ensure leak proof connection.

Long radius pipe bends shall be used in lieu of standard pipe elbows, wherever feasible.

Gate valves shall be provided in the pressure line between the pressure tank and the actuator tank. The valves shall be located near the tank. Valves shall be cast or forged steel valve with rising spindle type and having flanged ends.

The piping shall be thoroughly pickled, cleaned, and the interior coated with oil before shipment. Prior to shipment, blind flange with gaskets on the flanged connections, screwed caps on the threaded ends and suitable plugs in plain ends shall be provided to prevent the entrance of foreign matter into the piping during shipment or while awaiting installation.

Water piping shall be made of heavy seamless carbon steel pipe and shall be flanged.

4.6.11 Control and monitoring

The main inlet valves and associated accessories/equipments shall be controlled and monitored at three levels:

- Automatically from respective Unit Control Boards (during individual automatic operation of the unit),
- By Computerized control and monitoring (SCADA) system through Operator's workstation (during centralized automatic control).

The details of control and monitoring requirement are defined in "Computerized Control and Monitoring System" and "Protection System".

The normal control by the SCADA system shall be through operator's work station in power house control room. It shall be the responsibility of the Contractor to make all necessary provisions required to achieve seamless and compatible interfacing of the system with SCADA system.

If the system consists of redundant subsystems, the priority of operation of such subsystems shall be selectable either from SCADA system or locally.

4.6.11.1 Instrumentation

The Contractor shall include suitable instruments, gauges, switches, contacts for achieving desired control and monitoring as defined in Sections - "Computerized Control and Monitoring System" and "Protection System".

The operating mechanism shall be provided with necessary instrumentation to accomplish the necessary alarms, indications and interlocking functions. Any other instrumentation envisaged during detailed engineering shall be provided.

The main inlet valve control system shall be provided with at least the following:

- Differential pressure gauges and switch for upstream and downstream valve disc pressure

- Pressure switch detecting the pressure in the upstream and downstream of the valve
- Non-contact type position switches showing open-closed and intermediate valve position for PV with associated by-pass valve and MIV with associated by-pass valve.
- Non-contact type position switches for interlocking purposes for the manual locking mechanism,
- Non-contact type position switches for engaged - released position of maintenance seal
- Any other instrumentation required during detailed engineering shall be provided.

4.7 Quality Control and Assurance

To ensure quality during each stage of work, the Contractor shall establish a system defining quality assurance plan/procedures during various stages of work.

The Contractor shall maintain quality control during manufacturing of equipment as per the approved quality assurance plan. Inspections and tests shall be carried out by the Contractor as per approved quality assurance plan with due regard to stipulations in "General Technical Specification" at various stages of manufacturing for assuring the full compliance of supply with the requirements of specification.

The Contractor shall follow approved site quality assurance plan and installation procedures. The Contractor shall maintain the quality records during site installation and commissioning which shall be produced to the Engineer for approval at defined stages.

Inspection and tests shall be carried out at site by the Engineer during installation and commissioning as described in relevant clauses.

All subcontractors including vendors associated in completing the supply and work under this section shall have their own quality assurance systems conforming to ISO 9000 series and certified by an internationally acceptable organization.

4.8 Drawings, Documents and Design Calculations

4.8.1 Design memorandum

The Contractor shall prepare and submit to the Purchaser a "Design Memorandum" of the proposed equipment/system fulfilling the contract specification/requirement for approval prior to submission of drawings and documents. The memorandum shall include the design philosophy, methodology, system description, input parameters for design, standard and codes, design and selection criteria, equipment data, material specification, major technical features, basic arrangement/ layout etc.

4.8.2 Drawings and documents

The Contractor shall submit all the drawings and documents in accordance with requirements stipulated in "General Technical Specification (GTS)". These drawings shall include at least the following:

4.8.2.1 Drawings & Documents to be submitted with Bid

- Longitudinal and transverse cross sectional arrangement of PV and MIVs & dismantling joint with salient dimensions
- Complete foundation details and loading diagram
- Upstream and downstream seal arrangement
- Control schematic drawing
- List of accessories and control devices
- Experience in application of preventive coatings on valve components along with details of coating suggested

4.8.2.2 Drawings & Documents to be furnished after award of work

- General arrangement, limit of supply, plan and section of valve, servomotor, etc.,
- G.A. and assembly drawing of valves, control valves, other bypass, air bleeder,
- Control schematic showing all devices, controls illustrating functioning of opening and closing sequences,
- Instructions for erection, operation and maintenance including replacement procedure for seal,
- Foundation drawings,
- Other drawings as per provision of technical specifications.

4.8.3 Design calculation

The Contractor shall submit the design calculation as per “General Technical Specification (GTS)” covering at least the following, for review / acceptance.

- Structural and stress analysis of different parts of main inlet valve during all loading conditions,
- Head loss calculation,
- Calculation of hydraulic forces and torque on the valve disc, and body during opening and closing of the valve for different positions of the valve and different turbine flow conditions,
- Sizing of hydraulic operating system,
- Sizing of closing mechanism and counter weight for closing against maximum flow under maximum head
- Calculations of sizing of by-pass valve,
- Calculations of foundation loads,
- Calculations of opening and closing time at various head conditions and discharges through the valve,
- Design calculations for air vent and anti-vacuum valve

The Contractor shall also provide other calculations as required by the Engineer for his approval of the Contractor's design.

4.9 Factory Acceptance Tests

The main inlet valve, by-pass valve and piping, operating mechanism, controls, locks and indicators shall be sub-assembled/assembled as per approved quality assurance plan in the Contractor's shop to assure satisfactory fit, and the assembly shall be match-marked and doweled, where required, to assure correct re-assembly and alignment in the field. The completely assembled valve and by-pass valve with operating mechanism shall be given an operating test, pressure test and leakage test. The testing requirement and methodology shall be subject to Purchaser's approval at design stage.

A record shall be made of shop measurements of all critical dimensions, diameters, concentricity, clearances, etc. of all the valves moving and stationary parts, which may affect the field erection and alignment or normal operation of the main inlet valve.

All necessary materials and labour for performing all these tests shall be provided by the Contractor.

The FAT shall be witnessed by the Engineer as per the requirements of approved Quality assurance programme.

4.10 Delivery, Installation and Commissioning

4.10.1 Site installation and commissioning

4.10.1.1 General

The Contractor shall follow the requirements of installation elaborated in "General Technical Specification (GTS)".

The Contractor has to do all the work related to assembly, erection, testing and commissioning complete in all respects. All necessary tools, plants, labour, materials including consumables for performing installation, testing, pre-commissioning and commissioning shall be provided by the Contractor.

The Contractor shall submit the necessary data/information, layout and foundation/support drawings well in advance.

The Contractor shall provide and install the concrete inserts/embedment; support steels and/or components for foundation/supports purpose as per approved erection drawings and coordinate the activities with civil contractors to keep his activities in synchronism with civil work. All installation for foundation shall be verified and accepted by the Engineer.

The Contractor shall use anchor fasteners for installation of piping, fixtures, mountings, conduits, cabling, panels etc. Chipping of concrete and/or taking support from reinforcement bars shall not be allowed.

The Contractor shall supply sufficient number of erection and commissioning spares based on their experience so that erection, testing and commissioning work progresses smoothly and is not hampered for want of such spares. These spares shall be in addition to the spare parts described under clause "Spare Parts".

4.10.1.2 Installation procedure

The Contractor shall submit detailed programs and the procedures to be adopted for erection / installation, testing and commissioning, at least three (3) months before start of erection activities/ installation, for approval of the Purchaser.

The installation procedure shall also have a section “site quality assurance plan” containing erection data sheets for various components. These sheets should specify site measurements/ inspections required to be made for ensuring proper installation.

4.11 Field Tests

All field tests including tests during installation, pre-commissioning, commissioning, performance and field acceptance tests shall be conducted by the Contractor, in the presence of representative of the Purchaser.

Procedure to be adopted for conducting the operational, pre-commissioning, commissioning, performance and field acceptance tests shall be submitted well in advance, at least six (6) months before start of relevant testing, for approval of the Purchaser.

The equipment / system shall be considered commissioned and ready for trial run only after successful operation for a “test service period” specified in sub clause “Performance Testing”. In the event of any failure, this period shall be repeated for any number of times till the successful operation as described above is achieved.

4.11.1 Tests during installation and pre commissioning

At least following field tests shall be performed to ensure that the butterfly valves meet specification provisions and manufacturer’s guarantee:

- Leakage test of all field piping with pressurized air and soap solution,
- Opening and closing of by-pass valve at no pressure/head,
- Opening and closing of main inlet valve at no pressure/head,
- Operation of all controls including the mechanical locking device,
- Testing and setting of all relays, limit switches and electrical control,
- Dielectric and insulation measurement tests on all electrical items i.e. solenoids; limit switches, wiring, etc. as per relevant standards,
- Operation Test to check sequence of operation and interlocks of bypass valve, air bleeder valve, valve plug and valve seats as per approved logic diagram.

Any other tests as recommended by manufacturer or are necessary as per the provision of specifications and applicable IS/IEEE standards.

4.11.2 Commissioning tests

At least following field tests shall be performed during the commissioning of the butterfly valves to ensure that the valve meets specification provisions and manufacturer’s guarantee:

- Tests to determine leakage from valve seal under specified head conditions,
- Tests to determine closing time of valves at conditions defined,
- Tests to determine opening time of valves at conditions defined,
- Tests to determine operation and opening/closing time of main by pass valve at conditions defined,
- Flow stopping by use of counter weights for maximum turbine discharge conditions,

Any other tests as recommended by Manufacturer or are necessary as per the provision of specifications and applicable IS/IEEE standards.

4.11.3 Performance testing

If nothing unusual has been observed after in the operation of the main inlet valve, the test service period of 72 hours shall follow. During this test service period, the main inlet valve must operate satisfactorily.

The Contractor shall be responsible for the equipment during test service and also for the way it is operated. However, Purchaser's personnel will operate the equipment under the Contractor's guidance during test service period.

4.11.4 Field acceptance tests

Leakage through seals shall be verified after end of trial run period of thirty (30) days in addition to conduction of the same at works. The valve shall be accepted if the leakage is under permissible limit.

4.12 Spare Parts

The following spare parts shall be included in scope of supply.

S. No.	Description	Quantity
1	Pressure switch	1 no.of each type
2	Resistance temperature detector	1 no.of each type
3	Non-contact type position switches	1 no. of each type
4	Pressure gauge	1 no.of each type
5	Main inlet valve seal set	1 set
6	Bushes for main Trunnions	1 set
7	Main inlet valve body drain valve	1 no.
8	Seal rings for by-pass valve	1 set

4.12.1 Recommended spare parts

The Contractor shall furnish the list of recommended spare parts.

4.12.2 Special Tools

The Contractor shall propose the list of recommended special tools (other than those included under "Tools and Appliances" above) including their make and detailed specification as recommended by manufacturer(s) and to be accepted by the Purchaser.

4.13 Guaranteed and Technical Particulars

Guaranteed and Technical Particulars shall be furnished along with the bid. Bids lacking in this may be considered unresponsive. Particulars subject to guarantee shall be clearly marked

4.14 Completeness of Equipment

All fittings and accessories of the main inlet valve along with associated auxiliary & ancillary equipment that may not have been specifically mentioned in these specifications but are usually necessary for completion of above equipment, shall be deemed to be covered by the specification and shall be indicated and furnished by the contractor without any extra charges to the purchaser.

4.15 Deviations from Specification

While the purchaser does not bind himself to accept any deviation, due consideration will be given to any special devices or equipment put forward by the supplier with a view to increase the efficiency of the equipment and minimize the maintenance cost of the equipment as a whole.

Should the supplier wish to depart from these specifications, he shall submit a complete and limited list of such deviation, together with full particulars of the reasons for the deviation in a separate schedule with special reference to clause and paragraph nos. of this specification. Unless this is done and also the purchaser's concurrence in respect of such deviations is obtained in writing, the equipment offered shall be deemed to comply in every respect with these specifications.