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5 VALVES, PENSTOCKS AND APPURTENANCES

5.1 GENERAL

5.1.1 Scope

- 1 This part includes the specification for the manufacture, testing and supply and installation of valves, penstocks and appurtenances complete with frames, supports, anchor bolts, stems, stem guides and other appurtenances.

- 2 Related Sections and Parts are as follows:

This Section

Part 1,..... General

Part 3,..... Pipes and Fittings Materials

Part 4,..... Pipe Installation

Part 6,..... Miscellaneous Metal Works

Part 8,..... Protective Coatings and Painting

Section 1, General

Section 9, Mechanical and Electrical Equipment

Section 10, Instrumentation Control and Automation.

Section 21 Electrical Works

- 3 All valves are to be fixed to the pipelines with adaptor flanges for easy removal or installation.

5.1.2 References

- 1 The following standards or revised/updated versions are referred to in this Part:

ANSI B18.2.1Square and Hex Bolts and Screws

ANSI B18.2.2Square and Hex Nuts

ASTM B62Composition Bronze or Ounce Metal Castings

ASTM D256Test Methods for Impact Resistance of Plastics and Electrical
Insulating
Materials

ASTM D570Test Method for Water Absorption of Plastics

ASTM D638Test for Tensile Properties of Plastics

ASTM D648Test Method for Deflection Temperature of Plastics Under Flexural
Load

ASTM D695Test Method for Compressive Properties of Rigid Plastics

ASTM D696Test Method for Coefficient Linear Thermal Expansion of Plastics

ASTM D790Standard Test Methods for Flexural Properties of Unreinforced and
Reinforced Plastics and Electrical Insulating Materials

ASTM D1784Specification for Rigid Polyvinylchloride (PVC) Compounds and
Chlorinated Polyvinylchloride (CPVC) Compounds

ASTM D2000Classification System for Rubber Products in Automotive Applications

AWWA C500Metal-Seated Gate Valves

AWWA C501	Cast-Iron Sluice Gates
AWWA C507	Ball Valves 150 mm Through 1200 mm
AWWA C510	Double Check Valve Backflow-Prevention Assembly.
BS 4772	Ductile iron pipes and fittings
BS 5163	Predominantly key-operated cast iron gate valves for water works purposes.
BS 970 Part 1	General inspection and testing procedures and specific requirements for carbon, carbon manganese alloy and stainless steel
BS 2872	Copper and copper alloy forging stock and forgings
BS 2874	Copper and copper alloy rods and sections (other than forging stock)
BS 3416	Specification for bitumen based coatings for cold application
BS 4164	Specification for coal-tar-based hot-applied coating materials.
EN 593	Butterfly valves
EN 558	Industrial valves - Face-to-face and centre-to-face dimensions of metal valves for use in flanged pipe systems - PN and Class designated valves.
EN 1092	Flanges and their joints
EN 1171	Cast iron gate valves
EN 1561	Flake graphite cast iron
EN 1563	Founding. Spheroidal graphite cast iron
EN 1982	Copper alloy ingots and copper alloy and high conductivity copper castings
EN 3196	Nuts, hexagonal, self-locking in heat resisting steel.
EN 12334	Cast iron check valves for general purposes
ISO 9000	Quality Systems

5.1.3 Submittals

- 1 The Contractor shall obtain Engineer's approval of submittals before placing order for the following items.
- 2 Valves. Complete data for the supply and installation of all valves and appurtenances shall be submitted as follows:
 - (a) Product data:
 - (i) for each type and model of valve, provide.
 - assembly instructions,
 - preventative/corrective maintenance instructions
 - (ii) for each actuator, provide.
 - currents at the specified voltage corresponding to locked rotor,
 - maximum seating torque,
 - average running load, and speed and full information concerning actuator dimensions and weights shall be provided.
 - (iii) identification of valves and accessories by tag numbers, where applicable.

(b) The following detailed written procedures shall be submitted to supplement the above data:

- (i) installation procedures for fixing, supporting, and anchoring valves.
- (ii) test procedures for adjusting and testing valve assemblies.

3 Penstocks:

(a) Complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and information covering performance and materials of construction, power drive assembly, devices, and other accessories shall be submitted as follows:

- (i) Shop drawings, data and specifications for the equipment shall include, but not limited to:
 - anchor bolt placement in the concrete structure including projections from concrete or other surfaces
 - gate size, model numbers, opening sizes, elevations, locations, and materials of construction
 - stem sizes including details of connections, thread directions, and stops, and calculations for stem diameter and operators
 - stem guide details and locations
 - gear box types, model numbers, and ratios, including connections furnished for each type.
 - wall thimbles
 - motor data, including the motor manufacturer; minimum guaranteed efficiency and power factor at full load, 3/4 load, and 1/2 load; locked rotor current in amps; full load current in amps; motor speed in rpm; and mounting details.
- (ii) Factory Test Reports:
 - Before shipment of any material specified herein, the Contractor shall submit the results of all test reports for the approval of the Engineer.

4 Operations and Maintenance Manuals:

(a) The Contractor shall submit five copies of complete operation and maintenance manuals for penstocks and valves written in English in accordance with Part 1 of this Section. Required operation and maintenance data shall include, but not limited to

- (i) complete, detailed written operating instructions for each product or piece of equipment. Manuals must be specific to the products supplied herein and the application and operating conditions in Qatar. General manuals will not be accepted.
- (ii) complete, detailed preventative maintenance instructions.
- (iii) a complete inventory of all parts and components
- (iv) recommended spare parts lists and sources of supply for the parts.
- (v) all safety instructions relating to operation and maintenance procedures.
- (vi) name, address and phone number of manufacturer, manufacturer's authorised service representative
- (vii) troubleshooting instructions.

5.1.4 Quality Assurance

- 1 Valves, penstocks and appurtenances shall be supplied by approved manufacturers as designated in the Project Specification. Production facilities shall be quality assessed in accordance with ISO 9000 or equivalent.

5.1.5 Delivery, Storage and Handling

- 1 Packaged items shall be stored in their original packing and wrappers until ready for inspection by the Engineer. After inspection, all packaged items shall be repacked and rewrapped such that the items are sealed to the satisfaction of the Engineer and stored until ready for use or installation.
- 2 Valves and appurtenances shall be stored off the ground, protected from dirt and moisture, and protected from foreign material entering the ends.
- 3 All equipment shall be stored and handled in such a manner to protect equipment, finishes, and coatings, both internal and external.
- 4 During storage, gates for penstocks shall be placed in a position to support and prevent warping of gates and stems.

5.2 MATERIALS

- 1 Cast iron shall conform to EN 1561 minimum Grade 250 unless otherwise specified.
- 2 Ductile iron shall conform to EN 1563 unless otherwise specified.
- 3 Aluminium bronze shall conform to BS 2872 Grade CA 104
- 4 Bronze shall conform to ASTM B62 Grade 1, except that the maximum zinc allowance shall be seven percent and the maximum aluminium allowance be two percent, unless otherwise specified.
- 5 Gun metal shall conform to EN 1982 Grade LG2
- 6 Stainless steel shall conform to BS 970 Grade 316 S 31 unless otherwise specified.
- 7 Duplex stainless steel shall conform to BS EN 1.4507 unless otherwise specified.
- 8 Manganese steel shall conform to BS 970 Pt 1 Grade ISO M19.
- 9 Anchor bolts, assembly bolts, screws, nuts, and washers, including anchor bolts used in the installation and assembly of each unit shall be stainless steel unless otherwise specified, and of ample size and strength to safely withstand forces created by operation of the unit while subject to the hydrostatic heads described herein. The quantity and size of fasteners shall be as recommended by manufacturer, and as approved by Engineer. All bolt heads and nuts shall be hexagonal. Anchor bolts shall be furnished with two nuts each to facilitate installation and alignment.
- 10 All hand wheels, headstocks, foot brackets, guide brackets and thrust tubes shall be cast iron. All other materials for valves, penstocks and appurtenances shall be as specified for each item.
- 11 Unless otherwise stated Cast iron valves, penstocks and appurtenances shall be prepared and painted in accordance with part 8 of this Section.

5.3 SLUICE VALVES

- 1 These specifications are applicable to all sizes of sluice valves larger than 80 mm diameter. Sluice valves shall be of the following types.

- (a) Potable and treated sewage effluent - 80mm diameter up to and including 300mm diameter, to BS 5163 with resilient seating.
 - (b) All other uses other than (a) above, 80mm diameter up to and including 1,000mm diameter to EN 1171 metal seated.
- 2 Valves shall be of the double flanged cast iron wedge-gate type unless otherwise stated. Valves shall be cast iron body with renewable gun metal faces on body and wedge and bolt-on cast iron bonnet. All exposed valves shall be of the rising stem type unless otherwise specified or shown on the Contract Drawing. Rising stem valves shall also incorporate a combined yoke. Valves shall close clockwise.
- 3 Valves pressure ratings shall equal the class of pipe unless otherwise indicated on the Drawings.
- 4 Valve stems shall be of stainless steel SS316 S31, machined all over, with a machine cut robust trapezoidal or square form thread, operating in gunmetal.
- 5 Stem seals on valves of 350mm diameter and above shall be of the stuffing box and gland form arranged for easy replacement of packing and seal and shall be accessible for maintenance without removal of the valve from service. Stem seals on valves below 350mm diameter may be stuffing box and gland or 'O' ring. If 'O' ring seals are provided they shall be arranged such that they can be replaced without removal of the valve from service. If 'O' ring stem seals are provided, the Contractor shall provide with the valve, two replacement sets of rings labelled with the project number, manufacturer, valve model reference and size of valve.
- 6 Valves shall be provided with suitable handwheels as follows:
 - (a) diameter shall be adequate for the duty required.
 - (b) gearing shall be supplied where necessary to ensure that the required operating force applied by hand to the rim of the wheel does not exceed 250N (25Kgf)
 - (c) Handwheels shall have smooth rims and the direction of closing, which shall be clockwise, shall be cast on them.
- 7 The following shall apply to spindles:
 - (a) where possible and providing the valve is not subject to submergence, spindles shall be of the non-rising type and a cast iron bridle piece, or similar, shall be incorporated on valves of the rising spindle type for this purpose.
 - (b) for valves of 300mm bore and above, and for all motorised/actuated valves spindles shall be of the rising type. Thrust tubes shall be provided between the valve and headstock in order to absorb the thrust in both direction of operation. Thrust tubes shall incorporate all necessary fixings brackets and spindle guide plates. Headstocks shall incorporate a valve position indicator.
 - (c) where rising stem valves are subject to submergence the extension spindle shall also be of the rising type with the threaded portion positioned above top water level.
 - (d) extended spindle installations shall include all necessary brackets, intermediate supports etc.
 - (e) where extended spindles require to be operated at open flooring level, spindle guides or guide brackets shall be provided close to flooring level.
 - (f) all spindles shall be of stainless steel Grade 316S31 and shall be compliant with the requirements for valve stems.
- 8 Extension spindle couplings shall be of the muff type and shall be drilled with a nut and bolt for securing the spindle to the valve stem, which will likewise be drilled to accept the bolt.

- 9 Vandal and weatherproof clear polycarbonate tube covers shall be securely fitted to protect the threads of rising stems and spindles. Tubes shall be clearly and permanently engraved to indicate the position of the valve.
- 10 Where valves are required to be operated by tee keys, spindle caps shall be fitted. The caps shall be drilled and each provided with nut and bolt for securing to the spindle which shall likewise be drilled to accept the bolt. Where caps are fitted they shall be supplied complete with operating tee key. The extended spindle shall be such that the tee key will be operated at 0.9 to 1.2 m above floor level.
- 11 Where sluice valves above 350 mm bore are mounted with the spindle in the horizontal plane, valve bodies shall be fitted with renewable gunmetal machined gate slides and the gates with renewable hard bronze shoes accurately machined to reduce sliding friction.
- 12 All sluice valves above 500 mm bore (300 mm if power actuated) shall be provided with jacking screws. Valves above 350 mm bore where mounted in a horizontal pipeline shall be provided with feet.

5.4 BUTTERFLY VALVES

5.4.1 ECCENTRIC BUTTERFLY VALVE

- 1 Butterfly valves shall comply with EN 593 and be of the double flanged, non-wafer, bi-directional and eccentric (Double Offset) type.
- 2 Valves shall be suitably designed to protect the disc edge from the effects of corrosion and erosion.
- 3 The valve body ends shall be double flanged and the flange dimensions shall comply with the relevant requirements of EN 1092. The body shall be manufactured from Ductile Iron. The body parts shall be circular and the diameter not less than that of the nominal pipe bore. The valve body shall be provided with suitable lifting lugs.
- 4 The disc shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The disc shall be contoured to ensure the lowest possible resistance to flow and shall be suitable for throttling operation. Disc material shall be SS316 S31, otherwise, as specified in the contract document.
- 5 The shaft shall be designed to withstand the maximum torque that will be imposed by the operator. It may be in one piece or attached as two stub ends on opposite sides of the disc. That means of attachment of the shaft to the disc shall be by using fixings in a homogeneous corrosion-resistant material of a pattern which precludes the assembly becoming loose in operational service. The attachment of shaft to the disc shall be either by key, splined or polygon profile type. Grub screws, pins or clamps shall not be acceptable. The shaft material shall be stainless steel SS316 S31. Self-lubricating PTFE faced bearings with 'O' ring seals shall be provided.
- 6 The body seat shall be stainless steel SS316 S31 and the disc seat shall be one piece moulded nitrile rubber/EPDM. They shall be designed to be drop tight in either direction at maximum differential pressure.
- 7 Valves shall be provided with suitable stops to prevent movement of the shaft beyond the limits corresponding to fully open and fully closed position of the disc.
- 8 A suitable external locking device shall be provided on the non-drive shaft end, to enable the geared unit to be removed with the valve remaining in service in the open or closed position.
- 9 Fasteners like nuts, bolts and washers of stainless steel SS316 S31 shall be provided.

- 10 Unless otherwise specified each valve shall be provided with a suitable handwheel of adequate diameter for the duty required and gearing shall be supplied where necessary to ensure that the required operating force applied by hand to the rim of the wheel does not exceed 25 kgf.
- 11 Extension spindles, headstocks and foot brackets shall be provided where specified. Headstocks shall incorporate a valve position indicator.
- 12 The valve shall be closed by clockwise movement of an actuator or handwheel. Direction arrows clearly indicating 'open' and 'closed' positions shall be provided on the actuator or cast on the handwheel.
- 13 Valves shall be provided with a position indicator to show the positions of the disc, mounted on the driven shaft end.
- 14 All Valves above 350 mm diameter shall be provided with lifting lugs or eye-bolts

5.4.2 CONCENTRIC BUTTERFLY VALVE

- 1 Butterfly valves shall comply with EN 593 and be of the double flanged, non-wafer type.
- 2 Valves shall be suitably designed to protect the disc edge from the effects of corrosion and erosion.
- 3 The valve body ends shall be double flanged and the flange dimensions shall comply with the relevant requirements of EN 1092. The body shall be manufactured from Ductile iron, lined with rubber unless otherwise specified. The liner shall act a sealing element and shall also extended over the raised face of the flange to act as Gasket when valve is installed between pipe flanges.
- 4 The disc shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The disc shall be contoured to ensure the lowest possible resistance to flow and shall be suitable for throttling operation. Disc material shall be SS316 S31, otherwise, as specified in the contract document..
- 5 The shaft shall be designed to withstand the maximum torque that will be imposed by the operator. It may be in one piece or attached as two stub ends on opposite sides of the disc. The means of attachment of the shaft to the disc shall be by using fixings in a homogeneous corrosion-resistant material of a pattern which precludes the assembly becoming loose in operational service. The attachment of shaft to the disc shall be either by key, splined or polygon profile type. Grub screws, pins or clamps shall not be acceptable. The shaft material shall be stainless steel SS316 S31. Self-lubricating PTFE faced bearings with 'O' ring seals shall be provided.
- 6 Valves shall be provided with suitable stops to prevent movement of the shaft beyond the limits corresponding to fully open and fully closed position of the disc.
- 7 A suitable external locking device shall be provided on the non-drive shaft end, to enable the geared unit to be removed with the valve remaining in service in the open or closed position.
- 8 Fasteners like nuts, bolts and washers of stainless steel shall SS316 S31 be provided.
- 9 Unless otherwise specified each valve shall be provided with a suitable hand wheel of adequate diameter for the duty required and gearing shall be supplied where necessary to ensure that the required operating force applied by hand to the rim of the wheel does not exceed 25 kgf.
- 10 Extension spindles, headstocks and foot brackets shall be provided where specified. Headstocks shall incorporate a valve position indicator.

- 11 The valve shall be closed by clockwise movement of an actuator or hand wheel. Direction arrows clearly indicating 'open' and 'closed' positions shall be provided on the actuator or cast on the hand wheel.
- 12 Valves shall be provided with a position indicator to show the positions of the disc, mounted on the driven shaft end.
- 13 All Valves above 350 mm diameter shall be provided with lifting lugs or eye-bolts

5.5 REFLUX VALVES

- 1 Unless otherwise specified Reflux valves shall be swing type, double flanged cast iron conforming to EN 12334. Flange dimensions shall comply with the relevant requirements on EN 1092 PN16. Reflux valve shall have face-to-face dimensions in accordance with EN 558.
- 2 The valves shall be of the quick acting single door type designed to minimise slam on closure by means of heavy gunmetal-faced doors weighted as necessary. The valves shall be fitted with renewable gunmetal door sealing faces which shall be positively fixed. The door hinge pin/shaft shall extend through a sealing gland on the side of the body and be fitted with an external lever to permit back flushing.
- 3 Glands shall be of the stuffing-box type with the exception that for valves below 450 mm bore they shall be of the 'O' ring type.
- 4 The valve door shall be weighted to suit the application and the lever shall be of the heavy duty type designed for the additional of external weights should these be required at some future date.
- 5 Where there is a likelihood of surge pressures being generated reflux valves shall be of the low loss non-slam wafer type. They shall feature a spring action giving drip tight shut-off. The movement of the sealing plate shall not lead to scuffing of the seat material.
- 6 All reflux valves shall be suitable for operating in the horizontal plane unless otherwise specified.
- 7 Cover plates shall be of sufficient size to allow easy hand access for cleaning and service and shall be supplied complete with tapped bosses fitted with air release cocks.
- 8 Valves above 350 mm bore shall be provided with feet.
- 9 The design of the valve body shall be such that there is adequate clearance around and at the back of the door to minimise jamming by rags and debris. Stops shall be provided to limit the back lift of the door and shall be positioned to prevent fouling.
- 10 The hinge pin/shaft shall be stainless steel SS316 S31 and preferably square in section to ensure positive location of the door. If circular shafts are utilised the back flushing lever shall be located on a squared section, the diagonal dimensions of which shall be equivalent to the full diameter of the shaft. Both door and lever shall be positively and securely fixed to the hinge pin/shaft. Grub screws, pins (parallel to taper) or clamps will not be acceptable. All internal fixing devices shall be of stainless steel SS316 S31.
- 11 Reflux valves fitted to the delivery side of pumps shall be fitted with balance weights to minimise slam. If specified, they shall be provided with a totally enclosed proximity switch operated by an external cam fitted to the extended spindle. The proximity switch shall be of the metal clad type with sealed actuator and cable entry. Cam operated micro-switches will not be acceptable.

5.6 PLUG VALVES

- 1 Plug valves shall be eccentric and equipped with resilient faced plugs and be of non-lubricated type capable of handling abrasive and raw sewage. The plug valves shall have PN 16 flanged ends. Valves shall be furnished with manual operators as a unit. Each valve plug shall rotate 90 degrees from the fully open to the tightly shut position and shall seat at an angle of 90 degrees from the pipe axis in which the valve is installed.
- 2 Valves shall be satisfactory for applications involving throttling service and for frequent operation after long periods of inactivity. Valves with operators shall be suitable for operation with flow in either direction.
- 3 Valves shall be non-lubricated, with non-shock pressure differential acting in either direction; at 175 kPa differential across the valve, the valve will provide drip-tight shut-off. Valves 75 mm diameter and above shall have bolted bonnet design. Bodies shall be of high carbon cast iron or nickel iron having 1 % to 1.5 % nickel content. Valves shall have raised seats and all surfaces in contact with the plug face shall have 90 % pure nickel or coating. Valves shall have an average tensile strength of 240 MPa. Port areas of valves sizes greater than 100 mm shall be at least 75 % of full pipe area. Flanged valves shall be faced and drilled minimum PN 16 standard and shall have face-to-face dimensions of standard sluice valves. Valves shall have balanced plugs to assure low torque and drip-tight shut-off.
- 4 Valves shall be equipped with resilient plug facing to provide drip-tight shut-off without use of sealing lubricants. Even if small solids are trapped between the plug and seat, the resilient facing shall provide tight shut-off and prevent seat damage. Resilient plug facings shall be neoprene, ethylene propylene terpolymer, or other suitable materials capable of handling abrasives and raw sewage.
- 5 Valves shall have heavy-duty upper and lower guide bearings capable of resisting corrosion and lubricated by the liquid being handled.
- 6 Valves shall be actuated by means of lever for valves under 80 mm in size and by enclosed gear and handwheel operator for valves 100 mm and longer. All valves shall be supplied with operators which required less than 10 N/m torque for operation. Chain wheels with guides shall be furnished on all valves located 2 m or more above floor levels with stainless steel.
- 7 Valves operating devices shall be as specified in Clause 5.12 herein.

5.7 SURFACE BOXES

- 1 Surface boxes and covers shall be adjustable cast iron of the slip type and fitted to the sizes and depths of valves as shown on the Drawings. Covers and frames shall be heavy duty and be suitable for wheel loads up to 11.43 tonnes.
- 2 Surface boxes shall be coated by dipping or other equivalent means using a hot applied coal tar based material complying with BS 4164 or cold applied bitumen material complying with BS 3416. No coating shall be applied to any casting until its surfaces are clean dry and free from rust oil and deleterious material.

5.8 VALVE OPERATING TEE KEYS

- 1 Valve operating keys shall have a 50mm square socket. The length of the key shall enable the valve to be operated with hands at waist height. Unless otherwise stated in the Contract Documents one tee key per ten valves that are to be tee key operated, shall be provided for each site.

5.9 AIR VALVES

- 1 Air and gas relief valves shall be of the double orifice pattern with ductile iron bodies. The inlet flange shall be faced and drilled in accordance with EN 1092 PN16. Air valves for TSE or potable water shall be of the water type. Air valves for all other waste water work shall be of the sewage type.
- 2 The valve shall be adequately sized for the release of air/gas from the pipeline (or other container) without restriction of rate of filling or flow due to back pressure and also to allow admission of air during pipeline emptying at a rate sufficient to prevent excessive depression of pressure in the pipe.
- 3 Valves shall be designed to prevent the operating elements being in contact with the pipeline liquid by approved means such as the provision of an auxiliary float and chamber sufficiently large to isolate the orifice valves and seats throughout the rated operational range.
- 4 In applications where the pipeline characteristics may lead to liquid column separation with consequent possibility of surge a vented non-return valve shall be provided which allows air to enter freely on separation but controls explosion of air/gas as the liquid column re-joins.
- 5 In applications where the hydraulic conditions are such that pressures fall below atmospheric pressure during normal operation and where air inflow at that time could induce surge conditions, an air inflow check valve shall be incorporated.
- 6 All air and gas relief valves and associated isolating valves shall be works tested and capable of withstanding the same test pressures as the pipeline or vessel on which they operate.
- 7 Air valves and operating linkages that are not made stainless steel shall be pure epoxy resin coated in accordance with Part 8 of this Section.
- 8 Air valves shall be vented wherever possible directly into the wet well. In cases where this is not possible the Contractor shall provide suitable odour removal for the air expelled from the valve.
- 9 Where air may be drawn into the valve that contains dust, sand etc. means shall be provided for trapping/filtering this.
- 10 Air valves shall be installed in such a manner that routine maintenance can be carried out.
- 11 Air valves shall be fitted with an isolating sluice valves and gearing shall be provided where necessary to facilitate operation.

5.10 PRESSURE CONTROL AND RELIEF VALVES

5.10.1 General

- 1 The valve body shall be of cast iron conforming to EN 1561 with flanges conforming to EN 1092 PN16 or BS 10. The valve shall be extra heavy construction throughout. The valve interior trim shall be bronze as well as the main valve operation. All working parts shall be easily removed from the valve body for ease of maintenance. All controls and piping shall be of non-corrosive construction.

5.10.2 Pressure Reducing Valves

- 1 Pressure reducing valves shall maintain any desired downstream-delivery pressure for which the reducing pilot valve is adjusted provided the upstream head does not drop below a determined head. During low flow conditions, a resilient rubber valve seat shall ensure drop tight sealing. The valve shall be completely piped ready for installation.

5.10.3 Pressure Relief Valves

- 1 Pressure relief valves shall maintain constant upstream pressure by bypassing or relieving excess pressure, and shall maintain close pressure limits without causing surges. The main valve shall be a hydraulically operated, diaphragm-actuated, globe or angle pattern valve. It shall contain a resilient, synthetic rubber disc. The downstream pressure setting shall be adjusted by compression of the spring via the adjusted screw.

5.10.4 Pressure Regulating and Sustaining Valves

- 1 Pressure sustaining valves shall open and close in modulating action as required to maintain constant system pressure. On pressure reversal valve shall close tightly. Operation shall be completely automatic with only one adjustment required to change the pressure setting. Adjustable pressure range from 1.0 bar to 8.5 bar. The valve shall be "Y" pattern globe diaphragm actuated with pilot control. The diaphragm shall be made of reinforced neoprene and the pilot shall be bronze and all tubing copper.

5.11 PENSTOCKS

5.11.1 General

- 1 Each item of equipment shall be furnished and installed complete with all supports, anchor bolts, stems, stem guides, and appurtenances ready for operation. All mechanisms and parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be interchangeable. Penstock in sewage pumping stations shall be stainless steel/cast iron with gun metal seating suitable for corrosive environment.

5.11.2 Cast Iron Penstocks

- 1 Penstocks shall be suitable for their application, and shall be installed and positioned in such a manner as to allow ease of operation and maintenance.
- 2 Penstocks shall carry identification marks and brass name plates in accordance with EN 12334, which identify the penstock number and function.
- 3 Penstocks shall be clockwise closing.
- 4 Penstocks shall be watertight under the conditions stated for head and direction of flow.
- 5 All materials used in manufacture of the penstocks shall conform to the following minimum standards unless otherwise specified:

Cast Iron	EN 1561	Grade 250
Gunmetal	BS 1400	Grade LG2
Aluminium Bronze	BS 2872	Grade CA104
Stainless Steel	BS 970 Pt. 1	Grade 316 S31
High Tensile Brass	BS 2874	Grade CZ114
(Manganese Bronze)		
Manganese Steel	BS 970 Pt. 1	Grade ISOM19
Phosphor Bronze	BS 2574	Grade P13

- 6 Fixing nuts and bolts supplied by the manufacturer shall be of stainless steel.
- 7 Each penstock shall be provided with a suitable handwheel of adequate diameter for the duty required. Gearing shall be supplied where necessary:
 - (a) to ensure that the required operating force applied by hand to the rim of the wheel does not exceed 250N (25Kgf)
 - (b) if the handwheel cannot be readily accessed, extension spindles, headstocks and foot brackets shall be provided where specified

- (c) where possible, the extension spindle shall be of the rising type with the threaded portion position above top water level
 - (d) headstocks for non-rising spindle installations shall incorporate a position indicator.
- 8 Handwheels shall have smooth rims and the direction of closing which shall be clockwise shall be cast on them. Vandal and weather proof clear polycarbonate tube covers shall be securely fitted to protect the threads of rising stems and spindles. Tubes shall be clearly and permanently engraved to indicate the position of the valve.
- 9 The frames and doors of cast iron penstocks shall be made from close grained grey iron. The penstocks shall be designed so as to ensure tight closure while maintaining freedom of door movement during operation and minimising sliding wear of the sealing faces. They shall incorporate adjustable wedges or swivelling cams and actuating pegs manufactured from a non-corrodible material.
- 10 Headstocks and foot brackets shall be provided for non-rising spindle penstocks where the latter are specifically called for. Guide brackets shall however be provided where necessary. Non-rising spindles shall be fitted with thrust collars and arranged so as to transmit the thrust arising due to the operation of the penstock directly to the penstock frame. Where headstocks are required on non-rising spindle installations they shall incorporate a penstock position indicator.
- 11 Penstock spindles shall be of forged stainless steel SS316 S31 , machined all over, with a machine cut robust trapezoidal or square form thread, operating in a gunmetal nut.
- 12 Extension spindles shall be of stainless steel SS316 S31 and shall be compliant with the requirements for penstock spindles. Extension spindle couplings shall be of the muff type and shall be drilled and provided with a nut and bolt for securing the spindle to the penstock spindle, which shall likewise be drilled to accept the bolt.
- 13 Extended spindle installations of the rising type shall be provided for penstock of 300 mm bore and above, and for all motorised/actuated penstocks. These shall be of stainless or manganese steel or manganese bronze. Thrust tubes shall be provided between the penstock from and headstock in order to absorb the thrust in both directions of operation. Thrust tubes shall incorporate all necessary fixing brackets and spindle guide plates. All handwheels, headstocks, foot brackets and guide brackets shall be of cast iron.
- 14 Where penstocks are required to be operated by tee keys, spindle caps shall be fitted. The caps shall be drilled and each provided with nut and bolt for securing to the spindle which shall likewise be drilled to accept the bolt. Where caps are fitted they shall be supplied complete with operating tee key. The extended spindle shall be such that the tee key will be operated at 0.9-1.2 metres above floor level.
- 15 Where penstocks are provided with greasing nipples, these shall be fitted with extension tubes to facilitate lubrication from a nearby walkway or other readily accessible location.
- 16 Non-ferrous metal sealing faces shall comprise accurately machined gunmetal or bronze strips bedded and fixed to machined recesses in the frame and door. The strips shall be secured by non-corrodible countersunk screws. The faces of the strips shall then be brought together in the operation position and hand scraped to a watertight finish.
- 17 Handwheels, headstocks, foot brackets and thrust tubes shall be of cast iron.
- 18 Cast iron penstocks and headstocks shall be coal tar epoxy coated in accordance with Part 8 of this Section.

5.11.3 Stainless Steel Penstock

- 1 Where indicated on the drawings or elsewhere in the Contract Documents, penstocks for use in aggressive environments shall be manufactured from corrosion resistant materials as follows:
 - (a) Metal parts exposed to the atmosphere shall be manufactured from stainless steel to BS 970 Part 1, Grade 316 S11.
 - (b) The frame shall be fixed to the wall using nuts and bolts Grade 316 S11 stainless steel.
 - (c) The frame & door of the penstock shall be manufactured from stainless steel (Grade 316 S11).
 - (d) The seals used on corrosion resistant penstocks shall be suitable for the medium in which the penstock is immersed. Flexible rubber seals shall not be used on penstocks immersed in raw sewage for example, where sharp objects and grit may destroy the seal at the high velocities experienced when opening and closing the doors.
 - (e) Thrust tubes shall be provided, if required as per Design/ Site conditions/ Installation methods.

- 2 All other requirements shall be as specified in Clause 5.11.2 herein.

5.11.4 Plastic Penstocks

- 1 Plastic penstocks shall be of the flush invert type and the underside sealing face shall consist of high resilient material securely bonded into a channel or similar section forming the invert of the frame into which the bottom of the door shall effect a watertight seal.
- 2 The door of plastic penstocks shall be made from sheets of approved rigid cellular polymer sandwiched between sheets of approved rigid compressed composite plastics. The linear PVC or GRP materials shall be used. The doors thus formed shall have sufficient strength to withstand the required working pressure without deflection or distortion that would affect the operation of water-tightness of the penstock. Totally enclosed steel matrix shall be incorporated in the door construction to ensure adequate rigidity.
- 3 The sealing faces and side guides shall be EPDM having a high resistance to sliding wear and shall be to the approval of the Engineer. The sealing strips shall be securely fixed to the inner faces of the frames and adjusting devices or other means of ensuring freedom of movement without loss of seal shall be provided. The adjusting devices and fasteners shall be of stainless steel conforming to BS 970 Part 1 Grade SS 316 S31.
- 4 Spindle operating nuts shall be of gunmetal or manufactured from an approved ultra-high molecular weight polyethylene material. The operating nuts for the spindle retaining blocks shall be fixed in a visible position inside a separate gate lifting bracket bolted on to the top of the door with stainless steel fasteners. The operating nut or spindle retaining block shall not be contained within the door.
- 5 All plastic materials shall be non-toxic ultraviolet stabilised and shall have fire resistance as specified in BS 475 and be to Class P and Class I of Part 5 and 7 thereof respectively.
- 6 All other requirements shall be as specified in Clause 5.11.2 herein.
- 7 Plastic penstocks shall only be used when indicated in the Contract Documents and approved by the Engineer.
- 8 Thrust tubes shall be provided, if required as per Design/ Site conditions/ Installation methods.

5.11.5 Stoplogs

- 1 Stoplogs shall be fabricated from reinforced composite plastic material which is non-toxic and stabilised against ultraviolet light. Asbestos shall not be used in the manufacture of the stop-logs.
- 2 Plastic logs of 300 mm and 400 mm depths shall be furnished to provide closure of stoplog openings. Full depth gates shall not be acceptable.
- 3 Each log shall be provided with a stainless steel eye bolt at each end which fits into a recess in the under surface of the next log. Two lifting poles fitted with hooked ends for engaging the eye bolts shall be furnished for each facility and shall be mounted locally on a handrail supported pole rack. Poles and racks shall be constructed of aluminium and bolts of stainless steel.
- 4 Stoplogs shall provide a high degree of sealing with a leakage rate of less than 0.04 l/sqm of seating perimeter. Stoplog frame shall be for insertion in a wall and invert recess.
- 5 Anchor bolts shall be stainless steel.
- 6 Frames shall be manufactured from stainless steel BS 970 or BS 1449 Grade 316. All frames shall be suitably reinforced and include corner gussets where necessary. All fasteners shall be stainless steel.
- 7 Frames shall be fitted with seals which are molecularly incompatible with the closure material. Where necessary, the seals shall be fixed with corrosion resistant retaining strips and stainless steel fasteners.

5.12 OPERATING DEVICES

5.12.1 Lifts

- 1 Lifts shall be designed to operate the gate of the specified head with a maximum of 25 kg force applied to the device. The lift shall be a liftnut for tee key operation or gear/handwheel lift as designated.

5.12.2 Liftnut

- 1 The liftnut shall be hexagonal, gunmetal and internally threaded to fit the stem. The housing shall be cast iron and suitable for mounting in the head angle, gate frame extension or wall mounted bracket. The liftnut shall be flanged to maintain position in the housing and to accommodate the thrust developed during gate operation. Each lift shall be furnished with a bronze stop nut. The nut lift shall accept a T-bar operator or handwheel. Suitable T-bar operators shall be furnished.

5.12.3 Gear Lift

- 1 The gear lift mechanism if required shall be of the crank operated type with either a single or double gear ratio, depending on the lift load. Each type shall have a cast bronze lift nut threaded to fit the operating stem. Ball thrust bearings shall be provided above and below the flange on the lift nut to take the load developed in opening and closing the gate. Gears shall be of cast iron or steel, accurately machined with cut teeth, and smooth running with suitable shafts running in gunmetal sleeve bearings or roller bearings of ample size. All geared lifts shall be suitable for auxiliary motor operation. All gears and bearings shall be enclosed in a cast iron housing. Fittings shall be provided so that all gears and bearings can be periodically lubricated. The removable cast iron crank shall be fitted with a rotating handle. The lift mechanism shall be supplied with a cast iron pedestal, machined and drilled to receive the gear housing and suitable for bolting to the thrust tubes, operating floor or wall bracket. The maximum crank radius shall be 400 mm. The direction of rotation to open the gate shall be indicated on the lift mechanism. A cast iron stop nut shall be provided for each lift. All exposed cast iron shall be coated according to Part 8 of this section.

5.12.4 Handwheel

- 1 The housing shall be cast iron and shall be suitable for mounting on the head angle or pipe frame extension. The lift nut shall be flanged to maintain position in the housing and to accommodate maximum thrust developed during gate or valve operation. The lift nut shall be bronze and internally threaded to mate the stem. Each lift shall be furnished with a bronze stop nut. The steel or cast iron handwheel shall have a solid rim and shall be smooth and free of sharp edges and an arrow and the work "OPEN" shall be cast in the rim or attached to the handwheel. Handwheels generally shall be positioned on a headstock 750 mm above operating level.

5.12.5 Stem Covers

- 1 Stem covers shall be provided on all valves or gates with rising stems. Stem covers shall be clear butyrate with Mylar decals indicating open and close gate position and of sufficient length to totally enclose the stem when the gate is fully open. The top shall be closed and the bottom shall screw into a cast iron housing mounted on top of the gate operator. The inside of this housing shall be bored to the exact diameter of the stem cover to assure accurate alignment of the cover.

5.12.6 Actuators

- 1 Actuators are specified in Section 21 Part 33.

5.13 FLAP VALVES

5.13.1 Flap Valves (General Purpose)

- 1 The seat shall be one-piece cast iron conforming to EN 1561 Grade 250 with a raised section around the perimeter of the waterway opening to provide the seat. The raised section shall provide a seating plane diverging, top to bottom, from the plane of the mounting flange to assist in positive closure of the cover. The seat shall be shaped to provide two bosses extending above the top of the waterway opening for mounting the top pivot lugs. Pivot lug bosses shall be drilled and tapped for mounting studs. The flap shall be designed to be either butted to the face of a wall or to the outlet flange of a discharge pipe. The flaps shall be operable at a head of 10 m.
- 2 The cover shall be one-piece cast iron conforming to EN 1561 Grade 250 with necessary reinforcing ribs, with a lifting eye for manual operation, and with bosses to provide a pivot point connection with the links. Bosses shall be designed to place the hinge bolts in double shear when gate is assembled.

- 3 Each pivot lug shall be one-piece cast iron. Lugs shall have double bosses to place the top hinge bolts in double shear when they are assembled through the links. The lugs shall be adjustable in the horizontal plane without removal of the cover from the gate links. The adjustment shall allow the top pivots to be moved toward the gate seat for reduced sensitivity of the cover, or moved away from the gate seat to provide opening with a minimum differential head. Two studs shall be used to connect each pivot to the gate seat.
- 4 The links connecting the cover and pivot lugs shall be one-piece heavy duty cast iron. Each link shall be provided with bronze bushings at each pivot point. The bottom of the links shall be provided with an adjusting screw to properly align seating faces on the cover with respect to the seat. The links shall be designed to limit the double hinge action, preventing the cover from rotating sufficiently to become wedged in the open position.
- 5 Cast iron work shall be coated before delivery with a bituminous compound as specified in Clause 8.5.16.2 of QCS.

5.13.2 Flap Valves for Sea Water Applications

- 1 Flap valves frames including fixings for sea water and other aggressive applications shall be of stainless steel conforming to BS 970 Part 1. Sealing faces shall be phosphor bronze conforming to BS 2874.
- 2 Flap valves manufactured from corrosion resistant materials will also be acceptable for general purpose applications.
- 3 Flap valves above 1500 mm square shall be of the double door type.
- 4 Doors shall be of reinforced natural rubber compound of sufficient flexibility to maintain an efficient seal under minimal seating head conditions.
- 5 Door hinges shall be continuous across the full width of the door and manufactured from homogeneous polypropylenes, polyurethane or similar non-ageing material.

5.14 MISCELLANEOUS VALVES AND APPURTENANCES

5.14.1 Ball Float Valves

- 1 Ball float valves shall comply with BS 1212. Flanges shall conform to EN 1092.
- 2 PVC ball valves 50 mm and smaller shall be of the true union socket weld type, and valves 75 mm and larger shall be of the flanged type. Valves shall be rated at 1000 kPa at 50 °C unless otherwise specified.
- 3 Metal ball valves 60 mm and larger shall have brass balls with carbon steel bodies, and valves 50 mm and smaller shall have brass bodies. Valves shall have a Teflon seal and seat. Valves shall be rated at 1000 kPa at 100 °C unless otherwise specified.
- 4 Stainless steel ball valves shall be flanged with stainless steel body, ball and stem. Valves shall be rated at 1000 kPa at 100 °C unless otherwise specified.

5.14.2 Globe Valves

- 1 Globe valves shall be low-zinc bronze body type with tapered discs permitting close regulation of flow. Valves 75 mm and larger shall be flanged, Class 125 conforming to ANSI B16.1 in drilling and dimensions. Valves 60 mm and smaller shall be 1,000 kPa, and shall have screwed joints.

5.14.3 Quick Coupling Valves

- 1 Quick coupling valves shall be of robust construction consisting of a cast bronze body and dust cap with machined bronze valve cage and seat. The valve washer shall be neoprene rubber with stainless steel packing washer and fixing screw. The stem seal ring shall be neoprene rubber.
- 2 Double lug keys with swivel hose ells and standard 20 mm diameter hose connectors of the same manufacturer shall be supplied to the Employer's stores at the rate of one key for every five hose points. Each part shall be cast or machined bronze with neoprene rubber seals. The cost of supplying these keys complete shall be included in the rates for valves.

5.14.4 Emitters

- 1 Bubble emitters shall be brass with 12 mm BSP thread designed for adjustable flows.

5.15 FITTINGS

- 1 All flanges, fittings, coupling, valves, and appurtenances shall be rated for the pipeline pressure, except as noted on the Drawings.

5.15.2 Flanges, Gaskets, and Bolts

- 1 Flanges shall be PN 16 rating or as otherwise designated. Flange gaskets shall be ring type. Thickness shall be 1.5 mm for pipes 250 mm and smaller, and 3 mm for larger pipes. Flange assembly bolts shall be standard hexagon head machine bolts with heavy hot pressed, hexagon nuts and shall conform to EN 1092. Bolt length shall be such that after the joints are made up, the bolts shall protrude through the nut, but not more than 12 mm. All anchor bolts shall be stainless steel.

5.16 MECHANICAL COUPLINGS

5.16.1 Grooved End Couplings

- 1 Couplings shall engage and lock the grooved or shouldered pipe ends allowing some degree of contraction, expansion, and angular deflections. Coupling housing shall be of ductile iron or malleable iron and shall consist of two or more segments held securely together by at least two steel bolts. Sealing gasket shall be of such design that internal pressure in the pipe increases the tightness of the seal and shall be of materials suitable for the intended service. The coupling shall have a rated working pressure not less than the pressure rating of the pipe.
- 2 Corrosion protection shall be applied in accordance with the requirements specified in Clause 5.16.2 herein.

5.16.2 Flexible Couplings

- 1 Flexible (sleeve) couplings of the full sleeve type, split sleeve type, or flanged adapter type shall provide the requisite pipe flexibility without jeopardising pipe joint integrity due to hydraulic thrust, and shall have the same pressure rating as the pipe. Couplings shall have all metal bearing surfaces and shall be provided with galvanised steel bolts and nuts. Flexible couplings shall be restrained unless the Engineer has given his approval to omit this feature for specific cases. Specific requirements for each type are as follows:
 - (a) full sleeve type couplings shall be properly gasketed and shall be of a diameter to fit the pipe. Each coupling shall consist of a steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets. Stepped couplings of this general type shall be used when stepping from one pipe material to another of the same nominal diameter

- (b) split sleeve type couplings shall consist of one gasket, two housing clamps, and two bolts and nuts to obtain the flexibility for connecting the piping. Steel shoulders shall be provided and welded to the pipe ends to accommodate the couplings
 - (c) flexible flanged coupling adapters shall be of the sleeve type, consisting of steel middle ring, steel followers, gaskets, and steel bolts and nuts to compress the gaskets. The couplings shall contain anchor studs of strength adequate to hold the pipes together under a pull equal to the longitudinal strength of the pipes.
- 2 Couplings to be installed underground shall, in addition to any factory applied paint coating, site have one of the following corrosion protection systems:
 - (a) hot pour moulding with enamel complying with BS 4164 type IV Grade 105/8, to give a minimum of 20 mm thickness around all parts of the fittings
 - (b) laminate tape coating after priming and profiling with mastic
 - (c) paint coating with high build coal tar mastic to give a minimum dry film thickness of 500 μm in at least three coats.
- 3 Step couplings used in force mains with flexible pipes shall be provided with a restraint system where necessary to prevent longitudinal movement between the flexible pipe and the coupling. The restraint system shall be as shown on the Drawings or approved by the Engineer.
- 4 No joints shall be coated until hydrostatic testing of the joints is successfully completed.

5.17 FLOW CONTROL

5.17.1 Vortex Flow Control Devices

- 1 Where indicated on the drawings or elsewhere in the Contract Documents, Vortex Flow Control Devices shall be manufactured from corrosion resistant materials as follows:
 - (a) stainless steel to BS 970 Part 1, Grade 316 S31.
 - (b) the device shall be fixed using nuts and bolts of Grade 316 S31 stainless steel.

5.18 INSTALLATION AND TESTING

5.18.1 Installation

- 1 The Contractor shall obtain the necessary installation drawings from the manufacturer and shall store, transport, handle and install the valves, penstocks, stoplogs, and appurtenances in strict accord with the manufacturer's drawings and recommendations. Care shall be taken during mounting of gates and logs to avoid warping the frames and to maintain clearance between seating faces.
- 2 All ferrous surfaces shall be finish coated in accordance with Part 8 of this Section.

5.18.2 Testing

- 1 Factory Testing:-
 - a. Penstocks shall be factory-tested for a seat clearance check in accordance with the applicable provisions of AWWA C501. Penstocks that do not conform with the testing requirements of AWWA C501 shall be made satisfactory or rejected and replaced. Before shipment of the gates, the Contractor shall submit certified copies of test reports to the Engineer for review.

- 2 Site Testing. Following completion of the installation of the penstock, the Contractor shall furnish the services of the authorised representative of the manufacturer to adjust and operate the gates of directed by the Engineer. Adjustment shall be made so that the gates operate smoothly, seat properly, and are installed to the tolerances recommended by the manufacturer. After the equipment has been tested and adjusted, the Contractor shall perform a field leakage test on each gate in the presence of the Engineer in accordance with the applicable provisions of AWWA C560/ BS 7775. Both seating and unseating heads shall be tested as applicable. If any of the equipment fails to meet the above test, it shall be modified as required and retested to conform with specifications, until the maximum allowable leakage, per AWWA C501, is not exceeded. Modifications or adjustments required to meet the test shall not impair the smooth operation of the equipment.

END OF PART