

**9.4 PARTICULAR SPECIFICATIONS
– MECHANICAL WORKS**

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9.4 PARTICULAR SPECIFICATIONS - MECHANICAL WORKS

9.4.1 PIPING

9.4.1.1 GENERAL

(1) *Scope of Work*

The Contractor shall furnish and install all pipes, fittings, valves and appurtenances which are shown on the Drawings.

(2) *Pipe and Fittings*

(I) Flanged Joints

Bolts and gaskets required for flanged joint connections to piping being installed shall be furnished and installed by the Contractor.

(3) *Schedule*

All piping which shall be furnished and installed by the Contractor under this Contract, shall be followed in Schedule I below.

SCHEDULE I

PIPING SCHEDULE FOR GOTHATUWA-KOLONAWA PUMP HOUSE (P-TR)

	Service And Location	Nominal Diameter (mm)	Pipeline Material	Lining (L) and Coating (C)	Joints	Remarks
1.	Pump suction piping	500	Ductile cast iron	(L) Tar epoxy, SYSTEM E1 (C) Tar epoxy, SYSTEM E1	Flanged	
2.	Pump suction wall pipe, submerged	500	Ductile cast iron	(L) Tar epoxy, SYSTEM E1 (C) Epoxy, SYSTEM D1	Flanged	With welded puddle flange
3.	Pump suction, interior	500 & 350	Steel	(L) Epoxy or Tar epoxy (C) Shop prime & field paint W/SYSTEM B1	Flanged & Flange adapter	
4.	Pump discharge, interior	250 & 500	Steel	(L) Epoxy or Tar epoxy (C) Shop prime & field paint W/SYSTEM B1	Flanged, SC W/ harness & Flange adapter	
5.	Pump discharge manifold interior	600	Steel	(L) Epoxy or Tar epoxy (C) Shop prime & field paint W/SYSTEM B1	Flanged, SC W/ harness & Flange adapter	
6.	Plant water system, interior	25	Galvanized steel	(L) None (C) Field prime & field paint W/SYSTEM B1	Flanged, victaulic & union	
7.	Sump pump discharge, Interior	65, and 80	Galvanized Steel	(L) None (C) Field prime and paint W/SYSTEM B1	Flanged, victaulic & union	

SCHEDULE I
PIPING SCHEDULE FOR FLOW METER IN PUMP HOUSE (P-TR)

	Service And Location	Nominal Diameter (mm)	Pipeline Material	Lining (L) and Coating (C)	Joints	Remarks
1.	Spacer pipe for flow meter	600	Steel	(L) Epoxy or Tar epoxy, (C) Shop prime & paint W/SYSTEM B1	Flanged & flange adapter	

SCHEDULE I
PIPING SCHEDULE FOR GOTHATUWA PUMP HOUSE (P-GT)

	Service And Location	Nominal Diameter (mm)	Pipeline Material	Lining (L) and Coating (C)	Joints	Remarks
1.	Pump suction bell, Submerged	500	Ductile cast iron	(L) Tar epoxy, SYSTEM E1 (C) Tar epoxy, SYSTEM E1	Flanged	
2.	Pump suction wall pipe, submerged	500	Ductile cast iron	(L) Tar epoxy, SYSTEM E1 (C) Epoxy, SYSTEM D1	Flanged	W/Water Stop ring
3.	Pump suction, interior	500 to 350	Steel	(L) Epoxy or Tar epoxy (C) Shop prime & field paint W/SYSTEM B1	Flanged, SC & flange adapter	
4.	Pump discharge and manifold, interior	400 to 500	Steel	(L) Epoxy or Tar epoxy (C) Shop prime & field paint W/SYSTEM B1	Flanged, SC W / harness & flange adapter	
5.	Plant water system, interior	25	Galvanized steel	(L) None (C) Field prime & paint W/SYSTEM B1	Flanged, Victaulic & Union	
6.	Sump pump discharge, Interior	65 and 80	Galvanized Steel	(L) None (C) Field prime and paint W/SYSTEM B1	Flanged, victaulic, & union	

SCHEDULE I

PIPING SCHEDULE FOR CHLORINATION HOUSE

	Service And Location	Nominal Diameter (mm)	Pipeline Material	Lining (L) and Coating (C)	Joints	Remarks
1.	Plant water supply, interior & exposed	50	Galvanized steel	(L) None (C) Field prime & paint W/SYSTEM D2	Flanged, victaulic & union	
	Buried			(L) None (C) Petrolatum C.P. Tape		
2.	Chlorine solution interior & exposed	63	PVC	(L) None (C) None	Flanged & Solvent weld	
	Buried	50	Stainless Steel	(L) None (C) None	Flanged, Push-on joint w/rubber ring gasket and rubber flexible joints	

9.4.1.2 DUCTILE IRON PIPING

(1) *Scope of Work*

Ductile iron piping as specified in the Piping Schedule for Gothatuwa-Kolonnawa Pump House and Gothatuwa Ground Reservoir and Pump House shall be provided as shown on the Drawings.

(2) *Flanged Joints*

Design maximum working pressure of 1.568 MPa shall be applied for all flanges of piping in the pump house.

9.4.1.3 STEEL PIPE

(1) *Scope of Work*

All piping inside pump houses will be welded steel pipe with fittings as specified.

(2) *Joints*

(i) Welding Joints

All steel pipes shall be shop fabricated and field welding will not be permitted unless otherwise noted on the Drawings.

Field welding shall be executed after being approved by the Engineer and all seam of field welding shall be tested with X-ray.

9.4.1.4 POLYVINYL CHLORIDE PIPE

(1) *General*

All piping shall be designed for a minimum working pressure of 1 MPa, unless noted otherwise.

Any pipe or fitting with an indentation greater than 10% of the wall thickness shall be rejected. Any pipe or fitting distorted out of round more than 5% shall be rejected.

(2) *References*

The following standards are referred to:

SLS 147: 1983	Specification for Rigid Unplasticized Polyvinyl Chloride Pipes for Potable Cold Water Supplies
BS 3505: 1986	Specification for Unplasticized Polyvinyl Chloride pressure pipes for cold portable water
BS 4346	Joint and fittings for use with Unplasticized PVC pressure pipes
BS 2494	Materials for Elastomeric Joint Rings for Pipe work and Pipelines
ASTM F 477	Specification for Elastomeric Seals for Joining Plastic Pipe
ASTM K 138	Rigid PVC Pipe for Pressure and Non-pressure Applications

JIS K 6353	Rubber Goods for Waterworks
JIS K 6380	Rubber Packing Material for Industrial Use
JIS K 6720	Polyvinyl Chloride
JIS K 6741	Unplasticized Polyvinyl Chloride Pipes for General Use
JIS K 6742	Unplasticized Polyvinyl Chloride Pipes for Waterworks

(i) Push-in Type

The pipe bell shall have O-ring gasket. O-ring gasket shall be styrene butadiene rubber (SBR) conforming to JIS K 6353, Class I-A or neoprene rubber (CR).

(ii) Welding Type

The socket section shall be designed by the manufacturer.

Solvent cement shall be conformed to BS 4336 Part 3. Solvent cement shall be mixed in strict accordance with the manufacturer's instructions. Any impurities in the cement shall be a cause for rejection. Data on the pot life of the solvent cement shall be approved by the Engineer.

(iii) Materials

Unless otherwise specified, pipe shall be rigid, Unplasticized polyvinyl chloride conforming to SLS 147: 1983, or equivalent.

Pipe shall be furnished in standard laying lengths of 6 m and shall be gray in color.

All fittings shall have the same characteristics and strength as the connecting pipes. Fittings shall be conformed to BS 4346 Part 1 and Part 2.

Fittings made of polyvinyl chloride shall be manufactured by a heat injection moulding machine or extruded machine. Fittings fabricated by heat-fusion or solvent-cement technique are not acceptable.

(iv) Joint

Unless otherwise specified, joints for underground pipe 10 mm and larger shall be push-on type using rubber gaskets.

Unless otherwise specified, joints for underground pipe and bends of 90 mm and 63 mm shall be welded using solvent cement. Other fittings of 90 mm and 63 mm shall be push-on type using rubber gaskets.

Unless otherwise specified, joints for all exposed pipes and for pipes smaller than 63 mm shall be welded using solvent cement.

All joints shall be designed to have the same characteristics and strength as the connecting pipe.

(v) Testing

Pipe fittings shall be tested in accordance with JIS K 6741, or JIS K 6742.

The Contractor shall furnish copies of certificates of tests carried out for quality control during manufacture of the pipe in accordance with Section 7.2 of SLS 147:1983 and Appendices A to E of BS 3505:1986 and shall if required by the Engineer undertake such additional tests as he considers necessary.

9.4.1.5 FLEXIBLE JOINTS AND COUPLINGS

(I) Rubber Flexible Joints

(i) General

Rubber flexible joints shall be designed to withstand all forces or all combination forces due to expansion and contraction, shear deflection, distortion and others of pipeline.

(ii) Design Requirement

Rubber flexible joint shall be designed and manufactured to meet the operating conditions and design requirements, as enumerated and tabulated below:

NOMINAL DIAMETER	MINIMUM ALLOWABLE EXPANSION	MINIMUM ALLOWABLE CONTRACTION	MINIMUM ALLOWABLE SHEAR DEFLECTION
<u>(mm)</u>	<u>(mm)</u>	<u>(mm)</u>	<u>(mm)</u>
40	13	15	10
50	17	19	13
65	19	21	15
80	21	23	16
100	24	26	20
125	26	28	24
150 to 300	44	56	50

(iii) Construction and Materials

Rubber flexible joint shall consist of cylindrical reinforcement rubber body, a neck flange at both ends, and stud bolts and nuts. The joint shall be so designed that any interior ferrous surface does not contact with handling liquid in service and lined with the rubber. The rubber used in fabrication of the rubber body which will be in service with chemical or other liquid specified shall be suitable type of synthetic rubber or rubber lined with Teflon or other suitable materials as approved by the Engineer. The neck flange shall be made of steel conforming to JIS G3101, Class 2. An aluminum alloy neck flange may be used under the approval of the Engineer.

(iv) Coatings and Linings

All exterior surface of middle ring and followers with bolts shall, unless otherwise specified, be painted in accordance with SUB-SECTION 9.1.6 PAINTING AND PROTECTIVE COATING, GENERAL SPECIFICATIONS – CIVIL WORKS.

All interior surfaces of middle ring shall be lined with epoxy system or coal tar epoxy system.

9.4.1.6 MISCELLANEOUS

(1) Stainless Steel Pipe

The stainless steel pipe shall conform to JIS G 3459, Stainless Steel Pipe and unless otherwise specified, the Schedule shall be 20S. Outside diameter and minimum wall thickness of the pipe at a nominal diameter of 80 mm shall be 89.1 mm and 4.0 mm respectively.

All fittings shall be shop fabricated and made from the same material of the pipe. Field welding will not be permitted. Type of stainless steel shall be 304.

9.4.2 VALVES, GATES AND APPURTENANCES

9.4.2.1 GENERAL

(1) *Scope of Work*

The Contractor shall furnish and install all valves, gates and appurtenances which are as shown on the Drawings.

(2) *Painting*

All exterior parts of the valves except RS type gate valve shall be shop primed with primer of PAINT SYSTEM B.

Painting shall conform to all provisions specified in the SUB-SECTION 9.1.6 PAINTING AND PROTECTIVE COATING, GENERAL SPECIFICATIONS - CIVIL WORKS.

(3) *Schedule*

All valves, gates and appurtenances which shall be furnished and Installed by the Contractor under this Contract shall be as summarized in SCHEDULE II below and strictly followed by the SCHEDULE.

SCHEDULE II
VALVE SCHEDULE FOR GOTHATUWA-KOLONAWA PUMP HOUSE (P-TR)

	Location	Valve No.	No. Required	Service and Location	Size mm	Operator	Others
1.	<u>GATE VALVES</u> Discharge manifold	GV – TR-D	1	Drain valve	80	Handwheel – manually gear operated	Class NP 16
2.	<u>BUTTERFLY VALVES</u> Pump suction	BV – TR-S1 to 4	4	Transmission pump suction	500	Handwheel- manually gear operated	Vertical shaft Class NP 10
	Pump discharge	MOBV-TR-1 to 3	3	Transmission pump discharge	500	Motorized Operator Type A W/limit switches	Vertical shaft Class NP 10
	Discharge manifold	BV-TR-1	1	Isolation	600	Handwheel- manually gear operated	Class NP 10
3.	<u>CHECK VALVES</u> Pump discharge	CV-TR1 to 3	3	Transmission pump discharge	500		Wafer, dual plate with high torque springs
4.	<u>AIR VALVES</u> Discharge manifold Piping	AV-TR1	1	Transmission pump discharge manifold Piping	100		Double orifice, Class NP 16

SCHEDULE II

VALVE SCHEDULE FOR GOTHATUWA GROUND RESERVOIR AND PUMP HOUSE (P-GT)

	Location	Valve No.	No. Required	Service and Location	Size mm	Operator	Others
1.	GATE VALVES						
	Reservoir drain	GV-GT-1 & 2	2	Pump House	300	Hand-wheel – manual	Class NP 10 W/bevel gear operator
2.	BUTTERFLY VALVES						
	Pump suction	BV-GT-S 1 to 3	3	Pump suction valve	500	Hand-wheel-manual	Class NP 10
	Pump discharge	MOBV-GT-1 & 2	2	Pump discharge valve	500	Motor operated Type A W/limit switches/ modulate	Class NP 10
	Discharge header	BV-GT-D	1	Pump House	600		
	Reservoir/ Pump bypass	BV-GT-BP1	1	Reservoir / Pump bypass	500	Hand-wheel / Gear operated	Class NP 10
	Reservoir inlet	BV-GT-R1 & R2	2	Reservoir Inlet	600	Hand-wheel / Gear operated	Class NP 10
	Inlet Flow meter	BV-GT-1 to 3	3	Flowmeter by-pass	350	Hand-wheel / Gear operated	Class NP 10
3.	CHECK VALVES						
	Pump discharge	CV-GT 1 & 2	2	Transmission Pump discharge	500		Wafer, dual plate W/high torque springs
4.	TOOTHED VANE BUTTERFLY VALVE						
	Inlet to Reservoir	MOCV-GT1	1	Transmission piping flow control	350	Motorized (Type A) with extension stem and support housing,/position potentiometer & limit switches.	Class NP10
5.	AIR VALVES						
	Transmission Main	AV-GT-1	1	Inlet manifold	100	Hand-wheel / Gear operated	Double orifice, Class NP16
	Pump House Outlet	AV-GT-2	1	Pump discharge manifold	100	Hand-wheel / Gear operated	Double orifice, Class NP16

SCHEDULE II
VALVE SCHEDULE FOR GOTHATUWA WATER TOWER

	Location	Valve No.	No. Required	Service and Location	Size mm	Operator	Others
1.	<u>BUTTERFLY VALVES</u> Tower bypass	BV-FV1	1	Tower bypass	450	Hand-wheel/Gear operated	Vertical, Class NP10
	Tower outlet	BV-GV1	1	Tower outlet (1500m ³)	450	Hand-wheel gear operated	Vertical, Class NP10
	Tower outlet to Existing Tower	BV-IV1	1	Tower outlet to Existing tower	150	<i>Hand-wheel / Gear operated</i>	Vertical, Class NP16
	Tower washout	BV-HV1	2	Tower washout	150 150	Hand-wheel /Gear operated	Vertical, Class NP16
2.	<u>GATE VALVE</u> Tower outlet(227m ³)	GV-1	1	Tower outlet	150	Hand-wheel /Gear operated	Vertical, Class NP16
3.	<u>CHECK VALVES</u> Tower outlet (227m ³)	CV-1	1	Tower outlet	150	Waffer, dual plate with high torque	Vertical Class NP 16

SCHEDULE II
VALVE AND FLOW METER SCHEDULE FOR MALIGAKANDA NEW RESERVOIR

	Location	Valve No.	No. Required	Function	Size mm	Operator	Notes
1.	<u>GATE VALVES</u>						
	New Reservoir	GV-MK-1	1	washout	300	Manual Hand wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	GV-MK-2	1	Old Dematagoda main	250	Manual Hand wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	GV-MK-3	1	New Dematagoda main	300	Manual Hand wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	GV-MK-4	1	Mount Mary main	250	Manual Hand wheel – extensions stem with beveled gear operator and floor stand	Class NP10
2.	<u>BUTTERFLY VALVES</u>						
	New Reservoir	BV-MK-1	1	Inlet	600	Manual Hand wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	New Reservoir	BV-MK-2	1	Outlet	800	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-MK-3	1	Outlet from old reservoir	1000	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-MK-4	1	Sectional valve	1000	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-MK-5	1	By-pass line	800	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10

	Valve House Manifold	BV-MK-6	1	Colombo/ Fort main	500	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-MK-7	1	San Sebastien main	700	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-MK-8	1	Kirillapone main	500	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-MK-9	1	Outlet from new reservoir	800	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-MK-10	1	Borella main	800	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-MK-11	1	Outlet from existing tank	800	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
3.	<u>AIR VALVES</u> Valve house	AV-MK-1	1	manifold	150	Double orifice	
4.	<u>FLOW METERS</u>						
	New Reservoir	FM-MK-1	1	Outlet	800	External clamp on ultrasonic meter compatible with existing system	
	Outlet of valve house	FM-MK-2	1	New Dematagoda main	300	External clamp on ultrasonic meter compatible with existing system	
	Outlet of valve house	FM-MK-3	1	Mount Mary main	250	External clamp on ultrasonic meter compatible with existing system	

SCHEDULE II
VALVE AND FLOW METER SCHEDULE FOR ELLIE HOUSE NEW RESERVOIR

	Location	Valve No.	No. Required	Function	Size mm	Operator	Notes
1.	BUTTERFLY VALVES						
	New Reservoir	BV-EH-I1	1	Inlet to NR1	500	Manual Hand wheel	Class NP10
	New Reservoir	BV-EH-I4	1	Inlet to NR2	500	Manual Hand wheel	Class NP10
	New Reservoir	BV-EH-O1	1	Outlet from NR1	1000	Manual Hand wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	New Reservoir	BV-EH-O2	1	Outlet from NR2	1000	Manual Hand wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	New Reservoir	BV-EH-O3	1	Outlet from NR3	1000	Manual Hand wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	New Reservoir	BV-EH-W1	1	Drain from NR1	500	Manual Hand wheel	Class NP10
	New Reservoir	BV-EH-W2	1	Drain from NR2	500	Manual Hand wheel	Class NP10
	New Reservoir	BV-EH-W3	1	Drain from NR3	500	Manual Hand wheel	Class NP10
	Valve House Manifold	BV-EH-BP2	1	Reservoir By-pass isolation valve	1000	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-EH-BP1	1	Reservoir By-pass supply line	500	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-EH-D1	1	Distribution main	900	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-EH-D2	1	Distribution main	600	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-EH-D3	1	Distribution main	300	Manual Hand Wheel – extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House	BV-EH-D4	1	Distribution	500	Manual Hand Wheel	Class NP10

	Manifold			main		- extensions stem with beveled gear operator and floor stand	
	Valve House Manifold	BV-EH-D5	1	Distribution main	450	Manual Hand Wheel - extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-EH-D6	1	Distribution main	500	Manual Hand Wheel - extensions stem with beveled gear operator and floor stand	Class NP10
	Valve House Manifold	BV-EH-D7	1	Distribution main	600	Manual Hand Wheel - extensions stem with beveled gear operator and floor stand	Class NP10
	Existing Supply Manifold	BV-EH-S1	1	Sectional valve	500	Manual Hand Wheel	Class NP10
2.	<u>SLUICE GATES</u>						
	Reservoir Outlet	SG-EH-01 to 03	3	Inside Reservoir @ outlet pipe	1000	Non-rising stem, standard invert, thrust on frame	Wall mounted, on-seating head 6 m circular aperture
	Reservoir dividing walls	SG-EH-1 to 4	4	Interconnecting reservoir cells	1000	Non-rising stem, flush invert, thrust direct on frame	Wall mounted for off-seating head 8 m circular aperture
3.	<u>AIR VALVES</u>						
	Valve house	AV-EH-1	1	manifold	150	Double orifice	
4.	<u>FLOW METERS</u>						
	Distribution Main	FM-EH-1	1	New main to Mattakuliya	500	External clamp on ultrasonic meter compatible with existing system	
	Distribution Main	FM-EH-2	1		900	External clamp on ultrasonic meter compatible with existing system	
	Outlet of reservoir	FM-EH-3	1	Discharge manifold	1000	External clamp on ultrasonic meter compatible with existing system	

9.4.2.2 GATE VALVES

(1) *Gate Valve (50 mm to 600 mm)*

Two Gate Valves, GV-GT-WO1 & WO2 of 300 mm diameter shall be horizontal shaft gate valve with bevel gear type manual operator and shall conform to all provisions in the VALVES, GATES, AND APPURTENANCES of the GENERAL SPECIFICATIONS-MECHANICAL WORKS, and in addition shall conform to the following requirements.

All the gate valves shall be designed to operate under horizontal installation.

9.4.2.3 VALVE OPERATORS

(1) *Electric Valve Operators for Butterfly Valves*

Electric valve operator for butterfly valves, MOBV-TR 1 to 3 and MOBV-GT 1 & 2 shall be Type A integral control type.

Electric valve operators shall travel from one extreme position to the other extreme position within 1.0 minute.

9.4.2.4 BUTTERFLY VALVES AND TOOTHED VANE BUTTERFLY VALVES

(1) *General*

The valve and appurtenances shall be products of well-established reputable firms with experience in the manufacture of the particular equipment hereinafter specified. The Contractor shall show proof that the valve manufacturer has designed, built and supervised installation of toothed butterfly valves and shall be required to furnish a list of installations using toothed butterfly valves manufactured and supplied by him.

(2) *Reference*

The following standards are referred to:

JIS G4102 Nickel Chromium Steels
JIS G5501 Gray Iron Castings

(3) *Design Requirements*

The valve shall be designed and manufactured to operate properly under operating condition specified above SCHEDULE II without subjecting any part of valve assembly to cavitation – induced damage or causing any noticeable vibration and noise of valve and its appurtenances. The valve shall be designed to have essentially equal-percent characteristic with valve opening.

(4) *Construction and Materials*

The toothed butterfly valve shall be of flanged ends, metal seated rotary control valve offering a range ability of 100 : 1 providing accurate and repeatable control over a wide range of flow rates. Metal-to-metal seat shall be provided for a complete seal in the both open and closed position.

The toothed butterfly valve, valve body and toothed vane shall be cast iron conforming to JIS G5501, Class 4 FC250 or ductile iron conforming to JIS G5502, Class 1 FCD 400 or carbon steel casting conforming to JIS G5101, Class 4, SC480 or better.

The stem shall be nickel chromium alloy steel conforming to JIS G4102 or type 420 stainless steel or better and stem seals shall be gland packing. In case of using nickel chromium alloy steel stem, all surface area of stem through gland packing box shall be chromium plated.

The valve operating mechanism shall be totally enclosed in a housing separate from the valve itself and shall be easily accessible for packing adjustment, inspection, maintenance or replacement without shutdown of the pipeline.

(5) *Electric Valve Operator*

Electric valve operator shall conform to all provisions specified in (1) General and (3) Electric Valve Operators for Butterfly Valve and Plug Valve of GENERAL SPECIFICATIONS – MECHANICAL WORKS and conform to the following requirements.

The electric valve operators shall be Type A, integral control type and shall have a valve position potentiometer and at least two (2) additional limit switches which shall be of the adjustable type capable of being set to trip at any position between fully open and fully closed valve positions.

(6) *Shop Test*

The valve shall be shop-operated Five (5) times from the fully closed to the fully opened position, and the reverse, under a no-flow condition to demonstrate that the complete assembly is workable.

(7) *Installation*

The valve shall be installed true to alignment, completely plumb and rigidly supported.

(8) *Field Inspection and Testing*

The Contractor shall be responsible for testing the valve and valve operators after installation at the site, until it has been demonstrated to the Engineer's satisfaction that the valves as installed function in accordance with these specifications and show smooth operation, free from any evidence of improper assembly, misalignment of parts, binding, scraping, leakage or other defects.

(9) *Tools and Spare Parts*

One (1) set of special tool for operation and maintenance shall be provided.

List of spare parts for 5 years of operation in manufacturer's recommendation shall be furnished.

9.4.3 MAJOR PUMPING UNITS

9.4.3.1 GENERAL

(1) Scope of Work

The Contractor shall furnish and install three (3) units of transmission pump, P-TR 1 to 3 in Gothatuwa - Kolonnawa Pump House and two (2) units of pump, P-GT 1 & 2 in Gothatuwa Pump House.

9.4.3.2 DOUBLE SUCTION VOLUTE PUMPS

(1) General

All pumps shall conform to the provisions in the SUB-SECTION 9.3.4 MAJOR PUMPING UNITS GENERAL SPECIFICATIONS – MECHANICAL WORKS except the following provisions and in addition shall conform to the following requirements:

All pumps specified under this Section shall be furnished by a single manufacturer and the manufacturer shall have a pump shop test plant at his own workshop.

(2) Design Requirement

Design requirements for Major Pumping Units shall be as described in Table 1 and Table 2.

Table 1 Design Requirements for Major Pumping Units (1/2)

Name of Pump	P-TR-1 to 3 Transmission Pump	P-GT-1 & 2 Pump
Type	Horizontal Shaft, Double Suction Volute Pump	
Number	3 units	2 units
Flow Quantity	14 m ³ /min	18 m ³ /min
Total Dynamic Head	50 m	30 m
Motor Capacity	165 kW	130 kW

Table 2 Design Requirements for Major Pumping Units (2/2)

Name of Pump	P-TR-1 to 3 Transmission Pump with supplementary trimmed impeller
Type	Horizontal Shaft, Double Suction Volute Pump
Number	3 units
Flow Quantity	11.85 m ³ /min
Total Dynamic Head	42 m
Motor Capacity	(120 kW) * * : estimated power consumption

(i) Supplementary Trimmed Impellers for Pumps (P-TR 1 to 3).

The Contractor shall furnish, install and reinstall as necessary, a supplementary trimmed impeller in each pump.

The Contractor shall provide for factory performance tests to be made with the supplementary trimmed impellers in place in addition to the tests with the normal impellers. The supplementary trimmed impellers are to be left installed in the pumping units on completion of satisfactory field testing.

(3) *Construction and Materials*

a. Transmission Pumps (P-TR-1 to 3) and Pumps (P-GT-1 & 2)

(i) Casing

The casing shall be horizontal split casing and shall be of cast iron conforming to JIS G5501, Class 3, FC 200 or better or ductile iron conforming to JIS G 5502, Class 2, FCD 400 or better.

(ii) Impeller

The impeller shall be of the enclosed double suction type and shall be of bronze casting conforming to JIS H5111, Class 2, BC 2 or better or stainless steel casting conforming to JIS G5121, type SCS 13 or better.

(iii) Wearing Rings

Removable wearing rings shall be provided on both the pump casing and impeller.

(iv) Bearings

Lubrication shall be grease. Grease lubrication and temperature detectors shall be provided by the pump manufacturer. Bearing temperature detectors shall be provided on each bearing and designed for both remote indication and direct reading local indication.

(v) Coupling

Coupling between pump and motor shall be flexible coupling and major parts made of carbon steel conforming to JIS G4059 or alloy steel approved by the Engineer.

(3) Motor

The motor and its starting system shall be capable of starting the pumps specified. The motor terminal box position shall conform to the position as shown on the Drawings. All motors for transmission pumps, **PM- TR- 1 to 3** shall be squirrel cage induction , drip proof type.

(4) Surge Vessel

The surge vessel shall be replaceable bladder type and consist of two each of 15 m³ vessels. The vessels shall be able to withstand a pressure of 16 bar and equipped with properly sized necessary auxiliaries including oil-less 15 kW compressor with air dryer and control panel supplying air to the vessels. The surge vessels shall be able to dissipate the surge from the water hammer by the pump operation, whatever large the water hammer could be.

Design requirement of Air Compressor shall be as described in Table 3

Table 3 Design Requirements for Air Compressors for Surge Vessels

Name of Equipment	Air Compressor for supplying air to Surge Vessels
Type	Package Type with air dryer
Air Quantity	1,750 L/min
Number	1 unit
Maximum Pressure	0.69 MPa (7 kg/cm ²)
Motor Capacity	15 kW

(5) Installation

The contractor shall install all equipment furnished under this Contract, except for the forming and placing of the concrete foundations. All handling and placing of the equipment including leveling and alignment shall be done by the Contractor.

The concrete foundation will be formed and placed by others in accordance with drawings furnished by the Contractor. Anchor bolts with pipe sleeves shall be furnished by the Contractor. The anchor bolts in suitable pipe sleeves will be installed by others at the time the concrete are poured. The Contractor shall furnish drawings, instructions, rigid templates, and supervision for installing the anchor bolts and sleeves.

After the Contractor has properly leveled and aligned the equipment shall be grouted by the Contractor. All shims shall be furnished by the Contractor. After the grout has adequately set, the shims shall be removed and the shim pockets will be grouted by the Contractor.

(6) Field Tests

The tests for pumps, (P-TR- 1 to 3) shall be made with supplementary trimmed impellers in place.

(7) Spare Parts and Tools

One (1) set of special tools for operation & maintenance shall be provided.

List of spare parts for 5 years for operation on manufacturers recommendation shall be furnished. The list shall include but not be limited to the following:

- (a). One (1) completely assembled rotating element with full design normal impeller for each pump unit P-TR-1 to 3 and P-GT-1 & 2. In addition to full design normal impeller above, one (1) supplementary trimmed impeller shall be included for pump units P-TR-1 to 3.
- (b). Shaft with sleeves, impeller with wearing ring, complete set of bearing and others.

(8) *Flow Meter*

(i) General

Three units of flow meters FE-TR-1 and FE-GT-1 & 2 shall be furnished and installed as shown on the drawings.

(ii) Specification

Design requirement of flow meter FE-TR -1 and FE-GT-1 & 2 shall be as described in Table 4 below.

Table 4 Design Requirements for Flow Meter FE-TR-1 and FE-GT-1 & 2

Name of Equipment	FE-TR-1	FE-GT-1	FE-GT-2
Type	Electro-Magnetic Flow Meter	Electro-Magnetic Flow Meter	Electro-Magnetic Flow Meter
Location	Discharge Main of Gothatuwa-Kolonnawa Pump House	Inlet of Gothatuwa Ground Reservoir	Outlet of Gothatuwa New Water Tower
Accuracy	± 0.5 % of actual flow	± 0.5 % of actual flow	± 0.5 % of actual flow
Flowmeter size, mm	600	350	300

9.4.4 MISCELLANEOUS PUMPING UNITS

9.4.4.1 GENERAL

(1) *Scope of Work*

In addition to the GENERAL SPECIFICATIONS-MECHANICAL WORKS, the following types of pumps shall be specified hereinafter and the units shall be complete with electric motors.

a. Submersible Sump Pumps

(2) *Design Requirement*

All interior ferrous and non-machined surfaces of casing and discharge column pipe shall be shop painted with tar epoxy paint, Paint System E1.

All ferrous surfaces of pump which will be below sump cover plate shall be painted with tar epoxy paint, Paint System E1.

All ferrous surfaces of motor and motor pedestal shall be painted with chlorinated rubber paint, Paint System B1.

9.4.4.2 SUBMERSIBLE SUMP PUMPS

(1) *General*

Pumps shall be heavy-duty submersible sump pumps and shall be a suitable type for the service specified. Pump discharge connection system shall be specified as the following two types:

- a) Quick gravity connection system
- b) Quick coupling system for flexible pipe

All essential and desirable motor protection devices, including overload protection, lubrication devices and other accessories for the pumping units shall be provided.

(2) *Design Requirement*

Submersible Sump Pump P-SU-TR-1 to 4, P-SU-EH 1 & 2 (Ellie House Valve House) and P-SU-GT-1 & 2 shall be equipped with 0.75 kW motor.

(3) *Construction and Materials*

(i) Pumps

The casing shall be the enclosed or non-clog centrifugal type. The impeller shall be enclosed, semi-open or open, non-clog type. The casing and impeller shall be made of cast iron conforming to JIS G 5501, Class 2, FC 150 or better.

For all pumps, replaceable wearing rings shall be provided between the impeller and casing. Wearing rings shall be bronze casting conforming to JIS H 5111, Class 6 or other materials approved by the Engineer.

Shaft shall be stainless steel, type 420 or other types of stainless steel approved by the Engineer. For all pumps, at least one (1) set of mechanical seal and oil seal shall be provided. All mechanical seals shall be removable and replaceable.

Bearings shall be anti-friction ball or roller type. For all pumps, upper and lower bearings shall be provided.

The pumps shall be provided with a suction strainer if specified. The strainer shall be made of cast iron, stainless steel or aluminium.

The pumps, P-SU-TR 1 to 4, P-SU-EH 1 & 2 and P-SU-GT 1 to 2 shall be provided with two (2) sets of eye hooks and lifting rings with chain and two (2) shackles, and a lifting chain which shall be of sufficient length to extend from the lifting ring to the operation floor as indicated on the Drawings. The lifting ring, shackles and chains shall be of ample size and shall be of stainless steel.

(ii) Discharge Connection

- a. The quick gravity connection for the pump discharge shall be a diagonal flange to a mating diagonal flange on the discharge piping base elbow bolted to the installation floor. The pump discharge diagonal flange shall be equipped with a bracket for sliding vertically on guide bars. The discharge piping base elbow shall be of cast iron. Guide bars shall be of stainless steel pipe and of sufficient length to extend from the base elbow to the operation floor as indicated on the Drawings. The stainless steel guide bars shall conform to JIS G 3459, Stainless Steel Pipes type 304 and schedule 40 Quick gravity connection system.

Quick coupling system for flexible pipe, two guide bars and guide bar holders with anchor bolts shall be provided for each pump.

(4) *Painting*

All interior ferrous and non-machined surfaces of casing and discharge column pipe shall be shop painted with tar epoxy paint, Paint System E1.

All ferrous surfaces of pump which will be below sump cover plate shall be painted with tar epoxy paint, Paint System E1.

All ferrous surfaces of motor and motor pedestal shall be painted with chlorinated rubber paint, Paint System B1.

All ferrous surfaces of the pump shall be shop painted with tar epoxy paint, Paint System E1.

Painting shall conform to the requirements as specified in the SUB-SECTION 9.1.6 PAINTING AND PROTECTIVE COATINGS, GENERAL SPECIFICATIONS – CIVIL WORKS.

(5) *Motors and Control Panels*

The motors shall be directly connected to the pump casing and completely sealed for submersion in water. Motors shall have sufficient rating to operate the pump at any head on its curve without overloading.

The motor of output 22 kW and smaller shall be designed and manufactured in accordance with JIS B 8325 Submersible Motor Pumps for Sumps or JIS A 8604 Submersible Pumps for Construction.

The built-in thermal overload protection with auto-cut relay shall be provided for the motors, of motor output 7.5 kW and smaller. The control panels for Sump Pumps P-SU-TR 1 & 2 and P-SU-GT 1 & 2 shall be provided.

(6) *Accessories and Spare Parts*

(i) Accessories

For each pump, all essential and desirable accessories for an installation and operation shall be furnished and installed, which shall include but not be limited to the following:

a. Pump with Quick Gravity Connection

- One (1) set of base elbow with anchor bolts and nuts
- One (1) set of cabtyre cables of 10 m long
- One (1) set of guide bars with holder (SS 304)
- One (1) set of lifting chain with ring and shackles (SS 304).

9.4.5 CONVEYING SYSTEM

9.4.5.1 GENERAL

(1) *Scope of Work*

The Contractor shall furnish and install following equipment for Gothatuwa-Kolonawa Pump House and Gothatuwa Pump House as specified herein respectively.

Hoist with geared trolley

(2) *References*

The following standards are referred to:

JIS B 8801	Electric Overhead Travelling Cranes
JIS B 8802	Chain Hoists
JIS B 8810	Testing Methods for Electric Chain Hoists
JIS B 8812	Link Chains for Chain Hoists
JIS C 9620	Electric Hoists
JIS G 3101	Rolled Steel for General Structure
JIS G 3192	Dimensions, Weight and Permissible Variations of Hot Rolled Steel Sections
JIS G 3454	Carbon Steel Pipes for Pressure Service

9.4.5.2 HOIST WITH GEARED TROLLEY

(1) *Design Requirement*

Design requirement of Hoist with geared trolley for Gothatuwa-Kolonawa Pump House and Gothatuwa Pump House shall be shown in Table 5 below.

Table 5 Design Requirements for Hoist with Geared Trolley

Location	Hoist for Gothatuwa-Kolonawa Pump House C-HO-TR	Hoist for Gothatuwa Pump House C-HO-GT
Type	Hand-Operated Hoist with Geared Trolley	Hand-Operated Hoist with Geared Trolley
Span	9 m	9 m
Number	1 unit	1 unit
Rating of Lifting Weight	5 ton	3 ton

9.4.6 VENTILATION SYSTEM

9.4.6.1 GENERAL

(1) *Scope of Work*

The Contractor shall furnish and install following equipment for Gothatuwa-Kolonawa Pump House and Gothatuwa Pump House as specified herein respectively.

Supply Fan and Exhaust Fan for Ventilation.

(2) *References*

The following standards are referred to.

- JIS B 8330 Testing Methods for Turbo-Fans and Blowers
- JIS G 3141 Cold Rolled Steel Sheets and Strip
- JIS H 4000 Aluminium and Aluminium Alloy Sheets and Plates, Strips and Coiled Sheets

9.4.6.2 DESIGN REQUIREMENT

(1) *Design Requirement*

Design requirement of Supply Fan and Exhaust Fan for Gothatuwa-Kolonawa Pump House and Gothatuwa Pump House shall be as shown in Table 6 and Table 7 below respectively

Table 6 Design Requirements for Supply Fans

	Supply fan for Gothatuwa-Kolonawa Pump House	Supply Fan for Gothtuwa Pump House	Supply Fan for Ellie House Valve House
Type	Propeller Fan	Propeller Fan	Propeller Fan
Number	1 unit	2 units	1 unit
Capacity	60 m ³ /min x 25 mm	70 m ³ /min x 25 mm	55 m ³ /min x 25 mm
Power	0.75 kW	0.75 kW	0.5 kW

Table 7 Design Requirements for Exhaust Fans

	Exhaust Fan for Gothatuwa-Kolonawa Pump House	Exhaust Fan for Gothatuwa Pump House
Type	<i>Roof Fan</i>	Roof Fan
Number	<i>2 units</i>	2 units
Capacity	70 m ³ /min x 13 mm	90 m ³ /min x 13 mm
Power	0.4 kW	0.4 kW

9.4.7 CHLORINATION SYSTEM

9.4.7.1 GENERAL

(1) *Scope of Work*

The Contractor shall furnish and install equipment and materials for the chlorination system of Maligakanda Reservoir and Ellie House Reservoir with all the necessary piping and appurtenances as specified herein respectively.

(2) *References*

The following standards are referred to:

JIS B 8246 Valves for High Pressure Gas Cylinder
JIS G 3454 Carbon Steel Pipes for Pressure Service

9.4.7.2 DESIGN REQUIREMENTS

(1) *Design requirements of the chlorination system are as follows:*

Plant name	:	Maligakanda Reservoir Chlorination House	Ellie House Reservoir Chlorination House
Design rate of plant	:	100,000 m ³ /d	110,000 m ³ /d
Dosage	:	0.2 mg/L	0.2 mg/L

(2) *Particular Requirement of the chlorination system*

- (i) Ventilation fan shall be operated during chlorine operation and if chlorine leakage eventually occur, the fan with motor operated suction shutter shall be automatically stopped and shut by signal from chlorine leakage detectors.
- (ii) Chlorine Gas Leakage Detectors shall send signal to red warning pilot lamp and audible alarm. Leaked chlorine gas remaining inside chlorination room shall be neutralized instantly with dispersed powdered slaked lime having average diameter of 10 micron from manual operating of Slaked Lime Disperser.
- (iii) Warning pilot lamp shall provide sufficient illumination even under daily sunshine.
- (iv) Wall mounted terminal box for electrical wiring shall be provided on the outside wall of the each chlorine house.

(3) *Equipment Manufacturer*

All the equipment specified under this Section shall be furnished by a single and shall be products of a manufacturer regularly engaged in the production of such equipment for at least five (5) years. The supplier shall have the sole responsibility for the proper functioning of the systems furnished.

The equipment specified herein shall be supplied by Suido Kiko Kaisha Ltd., Tokyo, Japan, Isomura Hosui Mfg. Co. Ltd., Tokyo, Japan, Pennwalt Corp., Capital Controls Company, Inc, Fischer & Porter Co., B-I-F, or an approved manufacturer of equal status.

Any reference to a specific manufacturer or model number is for the purpose of establishing a quality or parameter for specification writing and is not to be considered proprietary. In all cases any comparable source or device is acceptable.

(4) *Manufacturer's Service*

The supplier of the equipment and accessories, furnished under this Section shall execute the following services which shall be done by a fully qualified manufacturer's service Engineer(s).

(i) Supervision

Checking the installation of all components before power, water and chlorine supplies are applied.

(ii) Check Out

Placing the equipment into operation and necessary adjustments.

(iii) Instruction

The supplier shall execute at least 30 days training to instruct the Employer's personnel in the use, operation and maintenance of all the equipment and chlorination system including training in case of emergency such as chlorine leakage.

(5) *Certification*

The Contractor shall submit a certification from the manufacturer stating that the installation of the equipment is satisfactory, that the chlorination system is ready for operation and that the operating personnel have been suitably instructed in the operation and maintenance of the system.

9.4.7.3 CHLORINATORS

(1) *Chlorinators Design*

The design requirement of chlorinators that shall be furnished and installed under this Contract is given as below.

Chlorine Flow	: 20 g/min (28.8 kg/d)
Type	: Wet type vacuum with automatic proportional pacing of chlorine feeder
Number	: 4 sets (2 sets each at Maligakanda Reservoir Chlorination House and at Ellie House Reservoir Chlorination House)

(2) *Construction and Materials*

The chlorinator shall be of manufacturer's standard model and shall incorporate pressure reducing valve, safety valve, gas flow meter, chlorine regulating valve, injector, water supply pressure gauge and other necessary appurtenances. The chlorine gas control system shall operate under vacuum and upon loss of vacuum the gas supply shall positively shut off.

The injector shall operate on the venturi principle to create a local loss of pressure at the throat of the device to less than atmospheric. The injector shall also mix the chlorine gas with water for feeding.

The injector shall have built-in spring-loaded check valve that will prevent water from backing up into the chlorine system. Maximum back pressure at the point of application shall be at least 0.294 MPa.

9.4.7.4 WEIGH SCALE

(1) Weigh Scale Design

The design requirement of weigh scale that shall be furnished and installed under this contract is given as below.

Scale Range	:	0 to 300 kg
Type	:	Dial Type
Number	:	2 sets (1 set each at Maligakanda Reservoir Chlorination House and at Ellie House Reservoir Chlorination House)

(2) Construction and Materials

The weigh scale, WS-CM 1 & WS-CE 1 shall be platform mechanical weigh scale. Weigh scale shall be designed to support and weigh one (1) standard 68 kilogram each of chlorine cylinder, weighing approximately 250 kilograms when full. Mechanical locking device for platform shall be provided.

The dial indicator shall be graduated in not greater than 5 kg increments and shall be capable of full scale tare adjustment. Tare adjustment shall not require the use of any special tools and shall be easily accessible for adjustment without dismounting the indicator. The dials shall be not less than 200 mm in diameter.

Hardwood cylinder loading and unloading guide block of maple or other types of wood approved by the Engineer shall be furnished and installed in accordance with the details as shown on the drawings.

9.4.7.5 CHLORINATOR BOOSTER PUMPS

(1) Chlorination Booster Pump Design

The design requirement of chlorination booster pumps that shall be furnished and installed under this contract is given as below.

Type	:	Horizontal Shaft, Single Suction Pump
Capacity	:	0.075 m ³ /min x 30.5 m TDH (Suction dia. of 40 mm x delivery dia. of 32 mm)
Motor	:	1.5 kW (Totally enclosed fan cooled)
Number	:	6 units (3 units each at Maligakanda Reservoir Chlorination House and at Ellie House Reservoir Chlorination House)

Pump head and casing shall be designed to withstand the maximum design pressure: 0.294 MPa and shall be hydraulically tested at 150% of the said design pressure. Pump head and casing shall be cast iron. All other major parts such as impeller, splined shaft, splined shaft nut, intermediate chamber and guide vane shall be stainless steel. Intermediate bearings shall be tungsten carbide/ceramic and shaft seal shall be tungsten carbide/ ceramic.

9.4.7.6 CHLORINE CYLINDER LIFTING CRANE

(1) Chlorine Cylinder Lifting Crane Design

The design requirement of Chlorine Cylinder Lifting Crane that shall be furnished and installed under this Contract is given below.

Type	:	Manual Hoist with geared trolley
Capacity	:	0.5 ton of lifting weight
Number	:	2 sets (1 set each at Maligakanda Reservoir Chlorination House and at Ellie House Reservoir Chlorination House)

9.4.7.7 RESIDUAL CHLORINE ANALYSER

(1) Residual Chlorine Analyser Design

The design requirement of Residual Chlorine Analyser which shall be furnished and installed under this Contract is given as below.

Type	:	Rotating platinum pole and platinum comparative pole with automatic temperature compensating resistance type
Range of measuring	:	0-3 ppm (total and free residual chlorine)
Representability	:	$\pm 2.1\%$ of full scale
Response time	:	Approximately four (4) minutes
Output signal	:	Proportional and isolated 4 –20 mA DC
Auxiliaries	:	Cylinders and reagent with necessary accessories
Number	:	2 units (1 unit each at Maligakanda Reservoir Chlorination House and at Ellie House Reservoir Chlorination House)

The residual chlorine analyzer shall be Type ZWM as manufactured by FUJI DENKI CO. LTD., TOKYO, JAPAN or Type 151 as manufactured by TOSHIBA CO. LTD., TOKYO, JAPAN or an approved equal.

9.4.7.8 SLAKED LIME DISPERSER

(1) Slaked Lime Disperser Design

The design requirement of Slaked Lime Disperser which shall be furnished under this Contract is given as below.

Type	:	Distinguisher Type (“Chloress” : Slaked Lime contained shall be kept with guaranteed durability of 5 years)
Capacity	:	200 kg of slaked lime contained
Emission Distance	:	At least 5 m to 7 m distance emission

Pressure source : N₂ gas
Number : 2 units (1 unit each at Maligakanda Reservoir Chlorination House and at Ellie House Reservoir Chlorination House)

9.4.7.9 VENTILATION FAN

(1) *Ventilation Fan Design*

The design requirement of Ventilation Fan which shall be furnished and installed under this Contract is given as below.

Type : Wall mounted fan
Capacity : 11 m³ / min x 25 mm x 0.07 kW
Number : 2 units (1 unit each at Maligakanda Reservoir Chlorination House and at Ellie House Reservoir Chlorination House)

9.4.7.10 CHLORINE GAS DETECTOR

(1) *Chlorine Gas Detector Design*

The design requirement of Chlorine Gas Detector with warning red lamp and audible alarm which shall be furnished and installed under this Contract is given as below.

Type : Non-reagent, semiconductor sensing type
(Send signal to warning red lamp and audible alarm installed outside wall of each Chlorination House.)
Number : 4 units (2 units each at Maligakanda Reservoir Chlorination House and at Ellie House Reservoir Chlorination House)

9.4.7.11 PROCESS PIPING AND VALVES

(1) *Process Piping*

All necessary chlorine process piping shall be furnished and installed so as to complete the chlorination system as shown on the drawings.

(i) Dry Chlorine Gas Piping

Dry chlorine gas piping shall be carbon steel pipe conforming to JIS G 3454, STPG 38, Schedule 80. Fittings shall be the suitable type for high pressure gas service.

(ii) High Pressure Water Piping

Pipe for high pressure water piping from discharge end of chlorination booster pump to the injector shall be stainless steel pipe, type 304 conforming to JIS G 3459, Schedule 40. Fittings shall be suitable type for high pressure service and shall be stainless steel, type 304.

(iii) Vacuum and Vent Tube

Tubing for vacuum and vent service shall be flexible tube and all necessary tube adapter shall be provided.

(iv) Chlorine Solution Diffusers

Chlorine solution diffusers shall be of steel pipe lined and covered with rubber as shown on the drawings. The lining shall be suitable for carrying high concentrated chlorine solution and shall be type NR 2105 or NR 2190 as manufactured by DAIKI ENGINEERING CO. LTD., TOKYO, JAPAN or Type Y-06 as manufactured by Yokohama Rubber Co. Ltd. The rubber lining shall cover all surfaces of the pipe, flanges and bolt holes and orifices.

The lining shall be capable of developing a rubber to metal bond of at least 549 N/cm² and shall have a tensile strength between 1,646 and 2,754 N/cm². Minimum lining thickness shall be 4.5 mm but the Contractor, in all cases, shall be governed by the manufacturer's recommendations.

Flanges for rubber lined steel pipe shall be of the slip-on welded forged steel type. Fittings may be of the rubber lined cast iron, flanged type. Gaskets to be used for rubber lined pipes shall be 3.0 mm thick when the flanges are bolted together.

All pipes to be rubber lined shall be new and straight, free from undue roughness on the inside, porosity, grease and oil. Rust and scale shall be removed by shot blasting before the lining is applied. All rubber lining shall be inspected visually and spark tested by the manufacturer using a test apparatus developing a minimum of 25,000 volts. Any pipe or fitting found to be defective shall be replaced.

(v) Other Pipe Materials

All other pipe materials to be used for the chlorination system shall be as specified in the SUB-SECTION 9.5 GENERAL SPECIFICATIONS – MECHANICAL WORKS.

(2) *Valves*

(i) Valves for Chlorine Service

Valves in pipelines handling high pressure chlorine gas shall be suitable for the service intended complete with all safety features to prevent dangerous leaks.

The body and one-piece bonnet and yoke shall be of carbon forged steel or carbon steel. The valves shall have wide deep stuffing boxes with Teflon packing.

(ii) Valves and Strainer for High Pressure Water Service

All valves and strainer for high pressure water service shall be stainless steel casting body and working pressure shall be 0.98 MPa.

(iii) PVC Check Valves

Check valves to be used for chlorine solution shall be swing type and all parts which may contact with chemical shall be of polyvinyl chloride, PVC, working pressure shall be 0.98 MPa.

(iv) Other Valves

All other valves to be used for the chlorination system shall be as specified in SUB-SECTION 9.3.3 VALVES, GATES and APPURTENANCES, GENERAL SPECIFICATIONS – MECHANICAL WORKS.

9.4.7.12 SAFETY CABINET

One (1) safety cabinet each shall be supplied containing the following equipment:

- a. Two (2) complete set of compressed air breathing apparatus, self-contained type with full face mask, regulator with alarm, harness, rescue mask, each with three (3) 6.75 litre aluminium alloy cylinders with maximum air charging pressure of 29.4 MPa.
- b. Two (2) complete sets of PVC protecting clothing consisting of
 - Jacket with set in sleeves, all purpose out inside storm front, stand-up corduroy collar, welded buttons (medium size).
 - Pants, single bib, elastic suspenders, nylon slide, roomy crotch, welded buttons, full length leg (medium size).
 - Hood suitable to fit over air mask.
 - Pair of black rubber, acid resistant gloves.
 - Rubber boots, knee high with puncture-proof sole and steel toe.

Provide one (1) complete set of first aid medicine kits with hard plastic carrying case. Contents of medicine kits shall be approved by the Engineer.

Provide one (1) complete set of an emergency repair kit with hard plastic carrying case. Contents of emergency repair kits shall be approved by the Engineer.

The cabinet shall be self-standing steel cabinet type with full sized double diamond glass front.

9.4.7.13 PROTECTION AGAINST CORROSION

All ferrous surfaces of equipment such as chlorinators, weigh scales, and chlorine containers shall be shop painted with the epoxy resin paint conforming to Paint System D2.

All other ferrous surfaces shall be painted with the epoxy resin paint conforming to Paint System D2.

All paint systems stipulated shall be as specified in the SUB-SECTION 9.1.6 PAINTING AND PROTECTIVE COATING, GENERAL SPECIFICATIONS – CIVIL WORKS.

9.4.7.14 MOTORS

All specified motors shall be the squirrel cage induction type with totally enclosed, fan-cooled enclosure.

9.4.7.15 ACCESSORIES AND SPARE PARTS

(1) Accessories

For each equipment, all essential and desirable accessories for an installation and operation shall be furnished and installed, which shall include but not be limited to the following:

(i) Chlorinator

- a. One (1) complete set of vacuum tube, 10 m long with 4 clamps and

- b. One (1) complete set of tool maintenance set with hard plastic case including 1 monkey wrench, 1 wrench, 1 screwdriver and 1 spanner.

- (ii) Chlorination Booster Pump

- a. One (1) complete set of pump base with anchor bolts and nuts.

- (2) *Spare Parts*

List of spare parts for 5 years of operation on manufacturer's recommendation shall be furnished. The list shall include but not be limited to the following spare parts.

- (i) Chlorinator

- a. One (1) complete set of injector
- b. One (1) complete set of gasket including 1,000 pieces of lead gasket
- c. Three (3) complete set of clamp and adapter for vacuum tubing.

- (ii) Chlorination Booster Pump

- a. One (1) complete set of bearing
- b. One (1) complete set of shaft seal.