9.3.3 VALVES, GATES AND APPURTENANCES

9.3.3.1 GENERAL

(1) Scope of Work

The Contractor shall provide all labour, materials, equipment and incidentals necessary to furnish and install, ready for operation, all valves with operators, accessories, paint, spare parts & tools & tools, tools, operating manuals and appurtenances as shown on the drawings and as specified herein. The materials and equipment shall be the product of an established and reputable manufacturer who has experience in the manufacture of the type of equipment herein specified. The manufacturer shall demonstrate to the Engineer that his products have successfully been in operation for a minimum of five (5) years.

Before installation of any valve, the Contractor shall submit and affidavit from the manufacturer certifying that each valve meets the requirements of this Specification, and a record of a specified test, to the Engineer for approval. No valve shall be installed prior to approval by the Engineer.

(2) Shop Drawings

The Contractor shall submit detailed working and shop drawings and schedules of all valves, accessories and appurtenances in accordance with Clause 6.1 to 7.2 of the GENERAL CONDITIONS OF CONTRACT.

Shop Drawings shall include but not be limited to the following:

a. Lists and schedule of material
b. Details of proposed joints and harnesses
c. Names of suppliers
d. Dates of delivery of materials to the job site.

Shop Drawings shall show size, details, materials and thickness of all items and all installation details.

(3) General Construction

All valves shall be of the size shown on the drawings or in the valve schedule, given in SUB-SECTION 9.4..2 of the PARTICULAR SPECIFICATIONS – MECHANICAL WORKS and, as far as possible, all valves of the same type shall be from one manufacturer.

All valves shall have following marking and they shall be designed cast in raised letters upon some appropriate part of the body.

a. Name of the Owner "NWSDB"
b. Name of mark of manufacturer
c. Year of manufacturing, 01 (means 2001)
d. Working pressure, NP10 (means 0.98 MPa) and
e. Arrow direction for valves designed for one-way flow only.

Valve ends shall be flanged ends except where otherwise specifically called out on the Drawings or in the SCHEDULE, SECTION 9.4.2 of the PARTICULAR SPECIFICATIONS – MECHANICAL WORKS. Where flanged ends are used, mating dimensions and drilling shall be in accordance with the flange schedule specified in SUB-SECTION 9.3.2 PIPING.

Thickness of flanges and shall conform to internationally accepted standards, or the Contractor shall determine the flange thickness and shall submit his design calculation.

All materials which will be specified hereunder shall conform to JIS, ASTM, BS, DIN or other internationally accepted standards.

Valves shall be equipped with hand lever, hand wheels, chain or hand, pneumatic or electric operators as shown on the Drawings or VALVE SCHEDULE, SUB-SECTION 9.4.2 of the PARTICULAR SPECIFICATIONS - MECHANICAL WORKS. Unless otherwise specified, manual operation valves shall have hand wheels. Valves shall open by turning to the left or counter clockwise. Operators shall have arrows cast thereon to indicate the direction of rotation for opening the valve.

All pipe connection openings shall be capped to prevent the entry of foreign matter prior to installation. Valves 50 mm in size and smaller shall be all bronze, unless otherwise specified, except for hand wheels which shall be of cast or malleable iron, provided with screw ends.

The minimum working pressure of valve shall be as specified herein unless otherwise shown in the valve schedules, SUB - SECTION 9.4.2 of the PARTICULAR SPECIFICATIONS – MECHANICAL WORKS

(4) Installation

All valves, gates and appurtenances shall be installed in accordance with manufacturer's directions at locations shown on the drawings. The installation shall be true to alignment and rigidly supported.

Pet cocks shall be installed at all points shown or called for on the drawings and at any other location where air binding of pipelines might occur.

All valve operators shall be installed according to the manufacturer's recommendations, as shown on the drawings and as specified herein.

Before setting the items specified, the Contractor shall check all plans and figures which have a direct bearing on their locations and the Contractor shall be responsible for the proper location of these valves and appurtenances during the construction of the structures.

(5) Testing

(i) General

The manufacturer shall notify the Engineer at least thirty working days prior to factory tests. The Engineer reserves the right to witness all tests.

(ii) Performance Tests

Each valve, gate and appurtenance shall be shop-operated three times from the fully closed to the fully opened position, and the reserve, under a no-flow condition, to demonstrate that the complete assembly is workable.

(iii) Leakage Tests

Valves, gates and appurtenances shall be shop-tested for leaks in the closed position. With the valve in the closed position, air pressure or hydrostatic pressure as directed by the Engineer shall be supplied to one face of the disc for the full test duration at the working pressure. The length of test shall be at least 5 minutes and there shall be no indication of leakage past the valve during the test period.

(iv) Hydrostatic Tests

Valves specified shall be hydrostatically tested. Hydrostatic tests shall conform to the following:

With the valve disc in a slightly open position, internal hydrostatic pressure equivalent to 150% of the specified working pressure shall be applied to the inside of the valve body of each valve for a period of 10 minutes. During the hydrostatic test, there shall be no leakage through the metal, the end joints, or the valve shaft seal; nor shall any part be permanently deformed. While undergoing testing, the valve body shall be struck with a hammer several times.

(v) Field Testing

When the valves, gates and appurtenances have been completely installed and as soon as operation conditions permit, they shall be given a field test and by the Engineer to demonstrate that they have been suitably installed, that they meet all requirements, are in good operating condition and are, in every way, adequate for the service intended.

(vi) Painting

All valves, gates and appurtenances, unless otherwise specified, shall be shop primed on the exterior in accordance with the SUB-SECTION 9.1.6 PAINTING AND PROTECTIVE COATING, GENERAL SPECIFICATION – CIVIL WORKS unless noted otherwise.

All valves, gates and appurtenances, unless otherwise specified, shall have an interior ferrous port, except finish or bearing surface, painted with two (2) coats of epoxy paint or coal tar epoxy paint having total minimum dry film thickness of 0.4 mm. Material of the said epoxy paint or coal tar epoxy paint shall conform to AWWA C210 or shall be certified by the recognized public health authorities for linings in potable water service.

9.3.3.2 SCHEDULE

Valve schedules include all required valves and gates in sizes 80 mm and larger. All valves less than 65 mm are shown on the drawings.

The completeness of these schedules is not guaranteed and the omission of valves in the schedule needed to complete the work shall not relieve the Contractor from his responsibility for installation of the work complete

9.3.3.3 GATE VALVES

(1) General

The following butterfly valves shall be specified hereinafter:

(a). Gate Valves, Normal Pressure Service, NP 10 (50mm to 500 mm)
(b). Gate Valves, High Pressure Service, NP 16 (50 mm to 300 mm)
(c). Resilient-seated Gate Valves (80 mm to 300 mm)
(d). Bronze Gate valves (80 mm and smaller)
(e). Stainless Steel gate Valves (15 mm to 300 mm)

(2) Reference

The following standards are referred to:

JIS	B2011	Bronze Gate, Glove, Angle and Check Valves
JIS	B2062	Sluice Valves for Waterworks
JIS	G5528	Epoxy-powder Coating for Interior of Ductile Iron Pipes and Fittings
JIS	H3250	Copper and Copper Alloy-rods and Bars
JIS	H5111	Bronze Casting
JWWA	B11510	kgf/cm^2 Sluice Valves for Waterworks
JWWA	B120	Resilient Seated Gate Valves for Waterworks
AWWA	C210	Liquid Epoxy Coating System for the Interior and Exterior of Steel Water Pipelines
AWWA	C213	Fusion-bonded Epoxy Coating for the Interior and Exterior of Steel water Pipelines
AWWA	C500	Gate Valves, 3 through 48 in. NPS, for Water and Sewage Systems
AWWA	C509	Resilient-seated Gate Valves, 3 through 12 NPS, for Water and Sewage Systems.
BS	5163	Metric Specification for General Purpose Cast Iron Wedge Gate Valves.

(3) Gate Valves, Normal Pressure Service, Class NP 10 (50mm to 500mm)

Gate valves, normal pressure service, working pressure of 0.98 MPa shall be cast iron or ductile iron body, bronze-mounted, non-rising stem (NRS) type gate valves and shall be designed and manufactured in accordance with AWW C500, BS 5163 or JWWA B115 and in addition shall conform to the following requirement:

Stem shall be of cast, forged or rolled bronze or copper allow or mantensitic series stainless steel. Stem sealing shall be of stuffing box or O-ring type. Packing for the stuffing box shall be made of nylon. Asbestos or hemp of jute packing materials shall not be used. O-ring stem seals shall have a minimum of two (2) "O" ring seals, of which at least one (1) shall be above the stem collar and replaceable under full working pressure while the valves is in fully open position.

(4) Gate Valves, High Pressure Services, Class NP 16 (50mm to 300mm)

Gate valves, high pressure service, design working pressure of 1.568 MPa shall be cast iron or ductile iron body, bronze-mounted, non-rising stem (NRS) type gate valves and shall be designed and manufactured in accordance with BS 5163 or other international accepted standard.

Valves shall conform to all provisions specified in the previous sub-section (3) Gate Valves, Normal Pressure Service, Class NP 10.

(5) Resilient-Seated Gate Valves (50mm to 30mm)

The valves shall be cast iron or ductile iron body resilient-seated gate valves and shall be designed and manufactured in accordance with JWWA B120 or BS 5163 or other international accepted standard. Design working pressure shall be of 1.568 MPa.

Valves shall be designed to provide an unobstructed waterway having a diameter of not less than the full nominal diameter of the valve when in the open position.

Resilient seats shall be applied to the gate and shall seat against a corrosion-resistance surface. The surface shall be non-metallic, applied in a manner to withstand the action of line fluids and operation of the sealing gate under long-term service. Resilient seats shall be bonded to the gate. All exposed mechanical attaching devices and hardware used to retain the resilient seat shall be of a corrosion-resistant material.

Bolts and nuts to be used for bonnet, packing plate, gland and others shall be stainless steel unless otherwise noted.

In addition to the requirement specified above, valves shall conform to all provisions specified in the previous Sub-section (3) Gate Valves, Normal Pressure Service, Class NP 10.

(6) Bronze Gate Valves (80mm and Smaller)

Bronze Gate Valves shall be designed and manufactured in accordance with JIS B2011 or approved equal. Working pressure shall be 0.98 MPa. Valves shall be equipped with either screwed ends or flanged ends.

Valves, in size 50 mm and smaller shall be bronze body, screwed bonnet, gate valves having a solid wedge, inside screw and rising stem.

Valves, in size 65 mm and 80 mm shall be bronze body, flanged bonnet, gate valves having a solid wedge, inside screw and non-rising stem.

The body shall be bronze casting conforming to JIS H5111, Class 6 or bronze casting having tensile strength not less than 196 N/mm^2. Disc shall be bronze casting specified above or copper conforming to JIS H3250, Class C3771 or copper having tensile strength not less than 314 N/mm^2. Stem shall be copper specified above.

(7) Stainless Steel Gate Valves (15 mm to 300 mm)

Stainless steel gate valves shall be solid wedge disc type valves with outside screw-and-yoke (OS&Y) rising stems and designing for handling acids. Valves shall have hand wheels and flanged ends. Working pressure shall be 0.98 MPa.

Unless otherwise specified, major parts of the valve such as body, bonnet, stem, disc, gland with gland bolts and nuts, bonnet bolts and nuts and other parts which may contact with handling liquid shall be made of Type 316 stainless steel and stainless steel casting.

9.3.3.4 BUTTERFLY VALVES

(1) General

The following butterfly valves shall be specified hereinafter:

(a). Butterfly Valves, Class NP 10
(b). Butterfly Valves, Class NP 16
(c). Toothed Vane Rotary Control Valves
(d). Wafer Butterfly Valves (50 mm to 600 mm).

All valves shall be equipped with manual operators with hand wheels unless otherwise specified.

(2) References

The following standards are referred to:

JISC	5501	Gray Iron Casting
JISG	5502	Spheroidal Graphite Iron Casting
AWWA	C504	Rubber-seated Butterfly Valves
BS	5155	Butterfly Valves
ISO	5752	Metal Valves for use in flanged pipe systems – face to face and centre-to-face dimensions
JISB	2032	Wafer type rubber-seated butterfly valves.

(3) Butterfly Valves - Class NP 10

Valves shall be double flanged, cast iron or ductile iron short body, rubber-seated butterfly valves, and shall be designed and manufactured basically in accordance with AWWA C504 or BS 5155 and in addition shall conform to the following requirements.

Valves shall be designed to be leak tight in both directions at a maximum working pressure of 0.98 MPa and at a maximum differential pressure of 0.98 MPa across the valve disc, and shall be suitable for a maximum velocity of 4.8 m/sec and for throttling service.

Laying length of valves shall conform to Type I and Type II specified in the following Table A. Valve bodies shall be designed to withstand the design requirements specified.

TABLE A LAYING LENGTH OF VALVES

VALVE DIAMETER mm	TYPE I mm	TYPE II mm
80	127	114
100	127	127
150	127	140
200	152	152
250	203	165
300	203	178
350	203	190
400	203	216
450	203	222
500	203	229
600	203	267
700	305	292
800	305	318
900	305	330
1000	305	410
1100	305	470
1200	381	470
1400	381	530
1500	381	600
1600	457	600
1800	457	670

Each shaft shall be a one-piece unit extending completely through the valve disc, or of the "stub shaft" type, which comprises two separate shafts inserted into the valve disc hubs. If of "stub" construction, each stub shaft shall be inserted into the valve disc hubs for a distance of at least 1.5 times the shaft diameter.

Materials of shaft shall be either austenite series stainless steel, Type 304 or 316, or high yield strength mantensitic series stainless steel. If Type 304 or 316 stainless steel are used, a minimum diameter extending through the valve bearings and into the valve disc shall be as specified in the following Table B.

TABLE B MINIMUM SHAFT DIAMETER *

VALVE DIAMETER mm	MINIMUM SHAFT DIAMETER mm
80	12.7
100	15.9
150	25.4
200	28.6
250	34.9
300	38.1
350	44.5
400	50.8
450	57.2
500	63.5
600	76.2
700	85.7
800	98.4
900	111
1000	120
1100	133
1200	143
1400	178
1500	184
1600	193
1800	216

Note: * *Based on use of stainless steel, Type 304 or 316.*

If high yield strength mantensitic series stainless steel such as Type 403, 420, 431 and others are used for the valve shaft, allowable torsional shear stress, not exceeding 25% of yield strength of the material used, shall be applied for design of valve shaft diameter.

Valve discs shall be made of cast iron or ductile iron or stainless steel casting and shall be of design with no external ribs transverse to the flow. The design of disc shall withstand full differential pressure across the closed valve disc without exceeding a working stress, equivalent to 20% of tensile strength of the material used.

Rubber seats shall be applied to either the body or the disc, shall be of synthetic rubber, and may be reinforced. Rubber seats of valve 700 mm in diameter and larger shall be of a design that permits removal and replacement at the site of the installation. Rubber seats shall be clamped, mechanically secured, or bonded to the body or disc. Rubber seats shall mate with stainless steel seating surface. Clamps and retaining rings for rubber seats shall be made of stainless steel and hardware used with clamps and retaining rings shall be stainless steel.

Valves shall be fitted with sleeve type bearings contained in the hub of the valve body. Valves, 350 mm in diameter and larger shall be equipped with either one or two thrust bearings, which shall hold the valve disc securely in the center of the valve. Sleeve and other bearings fitted into the

valve body proper shall be made of self-lubricated materials that do not have a harmful effect on potable water or rubber.

A shaft seal shall be provided where shafts project through the valve bodies for actuator connection. Shaft seals shall be designed for the use standard V-type packing; O-ring seals; O-ring-loaded, U-cup seals; or a pull-down packing. If O-rings are used, they shall be contained in a stainless steel or bronze removable recesses. If stuffing box and pull-down packing gland are used, the design of the valve and stuffing box assembly shall permit adjustment or complete replacement of packing without disturbing any part of the valve or actuator assembly except packing gland follower.

Gland or gland assemblies shall be made of stainless steel or bronze. Packing shall be made of resilient, non-metallic material suitable for potable-water service which shall not contain asbestos.

(4) Butterfly Valves, Class NP 16

Valves shall be double flanged, cast iron or ductile iron short body, rubber-seated butterfly valves. Valves shall be designed leak tight in one direction at a maximum working pressure of 1.568 MPa, and shall be suitable for a maximum velocity of 3.0 m/sec and for throttling service.

Valves shall conform to all provisions specified in the previous sub-section, (3) Butterfly Valves, Class NP 10, except the following items and in addition shall conform to the following requirements.

Valve bodies shall be designed to withstand the maximum working pressure specified and a maximum differential pressure of 0.98 MPa. Minimum thickness of valve body shall be calculated without exceeding a working stress equivalent to 20% of the tensile strength of the materials used.

Valve shafts shall be of high yield strength mantensitic series stainless steel such as Type 403, 420, 431 and others and valve shafts made by precipitation series stainless steel may be acceptable. Allowable torsional shear stress, not exceeding 25% of yield strength of material used shall be applied for design of valve shaft diameter.

Valve discs shall be designed to be off-centered. Rubber seats of valve shall be of a design that permits removal and replacement at the site of the installation without removing shafts from the valve body.

(5) Toothed Vane Rotary Control Valves

Valves shall be rubber seated, toothed vane disc butterfly type rotary control valve and shall conform to all provision in the previous sub-section, (3) Butterfly Valves. Class NP 10, except the following items and in addition shall conform to the following requirements.

Valves shall be designed to be leak tight, in both directions at a maximum working pressure of 0.98 MPa and shall be suitable for a maximum velocity of 3.0 m/sec and for throttling service.

Valves shall have hydrodynamically designed, toothed vane which splits up the flow stream and reduces noise and cavitation effectively while providing precise flow control.

Valve bodies shall be of double flanged long body type and shall be made of ductile iron conforming to FCD 450, JIS 5001, Class 3.

Shafts shall be of high yield strength mantensitic series stainless steel such as type 403, 420, 431 and others. Allowable torsional shear stress, not exceeding 25% of yield strength of the material used, shall be applied for design of valve shaft diameter.

Valve discs shall be designed to be centered.

Rubber seats shall be applied to the body and shall be clamped, mechanically secured, bonded, or vulcanized. Design of removal and replacement of rubber seats will not be required.

(6) Wafer Butterfly Valves

Valves shall be cast iron or ductile iron wafer body, rubber-seated butterfly valves, and shall be designed and manufactured basically in accordance with JIS B2051 or BS 5155 and in addition shall conform to the following requirements:

Valves shall be designed to be leak tight in both directions at a maximum working pressure of 1.568 MPa and at a maximum differential pressure of 0.98 MPa and at a maximum velocity of 4.0 m/sec and for throttling service.

Laying length of valves shall conform to laying length as specified in the following Table C. Valve bodies shall be designed to withstand the design requirements specified.

TABLE C

VALVE DIAMETER mm	LAYING LENGTH (ISO 5752 Water Short Series)
50	43
65	46
80	46
100	52
150	56
200	60
250	68
300	78
350	78
400	102
450	114
500	127
600	154

Each shaft shall be a one-piece unit extending completely through the valve disc, or of the "stub shaft" type, which comprises two separate shafts inserted into the valve disc hubs. If of "stub"construction, each stub shaft shall be inserted into the valve disc hubs for a distance of at least 1.5 times the shaft diameter.

Valve shafts shall be of high yield strength mantensitic series stainless steel such as Type 403, 420, 431 and others and valve shafts made by precipitation series stainless steel may be acceptable.

Valve discs shall be made of stainless steel casting and shall be of centered design with no external ribs transverse to the flow. The design of disc shall withstand full differential pressure across the closed valve disc.

Rubber seats shall be spool shaped rubber seating applied to the body and shall be made of EPDM or Buna-N (NBR).

Allowable stress, not exceeding 20% of yield strength of cast iron or ductile cast iron and allowable stress, not exceeding 30% of yield strength of stainless steel shall be applied for design of major parts of valve.

All valves shall be equipped with manual operators with hand wheels unless otherwise specified.

9.3.3.5 CHECK VALVES

(1) General

The following check valves shall be specified hereinafter:

(a). Swing Check Valves (50 mm to 600 mm)
(b). Bronze Swing and Lift Check Valves (50 mm and similar)
(c). Stainless Steel Check Valves (15 mm to 300 mm)
(d). Tilting Disc Check Valves (50 mm to 1,500 mm)
(e). Wafer Check Valves (50 mm to 1,200 mm)
(f). Spring Loaded Lift Check Valves (25 mm to 400 mm).

All check valves except tilting check valves, wafer check valves and spring loaded lift check valves mentioned above shall be constructed so that disc, seat, seat rings and other internal working parts which may become necessary for repairs shall be readily accessible, removable, and replaceable without use of special tools and removing the valve from the line.

(2) References

The following standards are referred to:

JISB	2011	Bronze Gate, Globe, Angle and Check Valves
JISB	2031	Gray Cast Iron Valves
JISH	5111	Bronze Castings
JISH	5114	Aluminium Bronze Castings
API	594	Wafer Check Valves
AWWA	C508	Swing-Check Valves for Waterworks service, 2 in. through 24 in. NPS.

(3) Swing Check Valves (50 mm to 600 mm)

Swing check valves shall be cast iron body and disc, and bronze seating type. The valves shall be designed and manufactured in accordance with JIS B2045 or AWWA C508. Working pressure shall be 0.98 MPa.

Valves shall be suitable to operate in a horizontal or vertical position with flow upward and when fully open, valves shall have a net-flow area not less than the area of a circle with a diameter equal to the nominal pipe size.

Valves shall be furnished with hinge arms, levers and springs or weights and also furnished with a by-pass pipe and by-pass valve as required by the schedule.

(4) Bronze Swing and Lift Check Valves (50 mm and smaller)

Bronze swing and lift check valves shall be designed and manufactured in accordance with JIS B2011 or approved equal. Working pressure shall be 0.98 MPa. Valves shall be equipped with screwed ends.

Swing check valves shall be suitable to operate in a horizontal or vertical position with flow upward. Lift check valves shall be suitable to operate in a horizontal position with flow upward when fully open. Both of swing and lift check valve shall have a net-flow area not less than the area of a circle with a diameter equal to the nominal pipe size.

Valves shall be bronze body, screwed bonnet and disc. Valves shall be designed to have bronze seating or resilient seating. Resilient seats shall be made of Teflon.

The body shall be bronze casting, and bonnet and disc shall be of bronze casting or copper. The said bronze casting and copper shall conform to the requirements specified in SUB-SECTION 9.3.3.3 (6) BRONZE GATE VALVES for (80 mm and smaller).

(5) Stainless Steel Check Valves (15 mm to 300 mm)

Stainless steel check valves shall be straightway, swing type and designed for handling acid. Valves shall have metal to metal seating. Working pressure shall be 0.98 MPa.

Valves shall be suitable to operate in a horizontal or vertical position with flow upward and when fully open, valves shall have a net-flow area not less than the area of a circle with a diameter equal to the nominal pipe size.

Unless otherwise specified, major parts of the valve such as body, bonnet, disc, hinge with hinge pin and other parts which may contact with handling liquid shall be made of Type 316 stainless steel casting.

(6) Tilting Disc Check Valves (50 mm to 1,500 mm)

Tilting disc check valves shall be cast iron or ductile cast iron body and disc, and bronze or stainless steel seating. Valves shall be designed for a working pressure of 1.568 MPa and shall be suitable for operation in a horizontal pipeline.

Body shall be two (2) piece construction bolted together. Seat rings shall be mounted on both valve body and disc and shall be made of bronze casting conforming to JIS H5111, Class 6 or Type 304, 403, 420 or other stainless steel. Mating surfaces of body seat and disc seats shall be machine finished. Hinge pin shall be of stainless steel specified above. Bushings of hinge pin shall be bronze casting specified above or aluminium bronze casting conforming to JIS H5114, Class 2 or 3.

Body shall be provided with suitable hand holes for cleaning and by-pass pipe with valve. Pivot pin housing shall be fitted with ball check grease fittings.

Dash pots shall be furnished with valves and designed to have valve opening and closing speed control devices. Dash post shall be approved by the Engineer.

(7) Wafer Check Valves (50 mm to 1,200 mm)

Wafer check valves shall be dual plate, two spring-loaded, semi-circular plates type. The valves shall be designed and manufactured in accordance with API 594, or other internationally accepted standards.

Valves shall be designed to fit between two pipe flanges and for working pressure of 1.568 MPa.

Valve body and plates shall be of cast iron, ductile iron or Type 316 stainless steel. Bronze casting plates may be permitted. Hinge pin, stop in and springs shall be of Type 316 stainless steel. Valves shall have resilient seating in the valve body unless otherwise specified. Seat materials shall be Buna-N (NBR).

Unless otherwise specified, the spring shall be high Torque type.

(8) Spring Loaded Lift Check Valves (25 mm to 400 mm)

Spring loaded lift check valves shall be cast iron body, spring loaded, center guided disc type with flanged ends. Valves shall be designed for a working pressure of 0.98 MPa.

The valves shall be suitable to operate in a vertical position with flow upward and shall consist of body, disc, upper guide, disc guide, reverse flow guide disc, spring and by-pass valve.

Body seat ring shall be bronze casting accurately threaded and screwed into the body. Disc shall have synthetic rubber seat bolted to the disc. Disc, upper guide, disc guide and by-pass valve shall be of bronze casting conforming to JIS H5111, Class 6. Spring shall be Type 304 stainless steel.

9.3.3.6 GLOBE VALVES

(1) General

The following globe valves shall be specified hereinafter:

(a). Angle hose valves (10 mm to 100 mm)
(b). Hose bibs (13 mm to 25 mm)
(c). Stainless steel globe valves (15 mm to 300 mm).

All valves shall be equipped with cast iron or ductile cast iron hand wheels.

(2) References

JISB 2011 Bronze Gate, Globe, Angle and Check Valves
JISB 2061 Faucets and Ball Taps
JISH 3100 Copper and Copper Allow-sheets, Plates, Strip and Coiled Sheets
JISH 3250 Copper and Copper Alloy-Rods and Bars
JISH 5111 Bronze Castings.

(3) Angle Hose Valves (10 mm to 100 mm)

Angle hose valves shall be bronze body Y-Gloss valves with renewable composition discs. Valves shall have rising stem and screwed ends with stainless steel replaceable quick couplings cap. Working pressure shall be 0.98 MPa. Valves shall be designed and manufactured in accordance with JIS B2011, Screwed Ends Angle Valves.

Discs shall be hard but sufficiently resilient to maintain tight seal within the pressure and temperature range and have high flexural and impact strength. Discs shall be made of Teflon or other materials approved by the Engineer.

Disc holder shall be made of bronze casting conforming to JIS H5111, Class 6 or copper conforming to JIS H3100, Class C2600P or JIS H3250, Class C3604 or C3771.

(4) Hose Bibs (13 mm to 25 mm)

Hose bibs shall be bronze body globe valves with renewable composition discs. Valves shall have rising stems, screw-in bonnet, screwed inlet and hose coupling outlet. Working pressure shall be 0.74 MPa. Valves shall be designed and manufactured in accordance with JIS B2061 and shall be swivel nose faucet, faucet with hose coupling or lawn faucet.

Stem with disc and disc nut shall be bronze, bronze casting or copper. Disc shall be medium soft composition as recommended by the manufacturer for the intended use.

(5) Stainless Steel Globe Valves (15 mm to 300 mm)

Stainless steel globe valves shall be metal-to-metal seating type globe valves with outside screw-and-yoke (OS&Y) rising stems and designed for handling acids. Valves shall have flanged ends and a net-flow area not less than the area of a circle with a diameter equal to the nominal pipe size. Working pressure shall be 1.568 MPa.

Unless otherwise specified, major parts of the valve such as body, bonnet, stem, disc, gland with gland bolts and nuts, bonnet bolts and nuts and other parts which may contact with handling liquid shall be made of Type 316 stainless steel and stainless steel casting.

9.3.3.7 DIAPHRAGM VALVES

Diaphragm valves shall be of the weir or straightway type as noted, with cast iron body, resilient reinforced rubber diaphragm and cast iron bonnet. They shall be fitted for spoked hand wheel operation.

The valves shall be used in water, air, and weak chemical service lines.

The reinforced rubber diaphragm shall be connected to a spindle actuated compressor so that it will be lifted to provide an adequate water-way for minimum pressure loss.

Further, the diaphragm shall be forced tight against the body even when the compressor is lowered. The diaphragm shall seal the bonnet compartment and working parts from the fluid stream. The diaphragm shall be capable of ready replacement without removing the valve body from the pipeline.

The valve shall be protected against corrosion with a minimum 3.0 mm thick of neoprene lining suitable for the service intended and consistent with associated piping unless otherwise noted.

9.3.3.8 PRESSURE REDUCING VALVES

Pressure reducing valves for plant water service shall be cast iron body, self-contained, direct-acting, spring-loaded type. Valves shall operate at a primary pressure range of 0 to 0.98 MPa and at an adjustable secondary pressure range of 0.1 to 0.4 MPa . Valves shall have flanged ends and the working pressure shall be of 0.98 MPa.

All ports subject to wear shall be accessible for repair or replacement without removing the valve from the line. Secondary pressure of valve shall be designed to be adjustable without any use of special tools while it is in service.

In all cases of pressure reducing valves installation, suitable cast iron body strainers shall be provided on the primary side of the valve. Two (2) gate valves, one for the primary side and the other for the secondary side of the pressure reducing valve shall be provided and by-pass line with gate valve shall be also provided. These gate valves specified above shall be the same size as the pressure reducing valve.

Two (2) pressure gauges, one for the primary side and the other for the secondary side of the pressure reducing valve shall be provided.

9.3.3.9 AIR VALVES

(1) General

The following air valves shall be specified hereinafter:

(a). Single orifice type air valves (25 mm)
(b). Double orifice type and combination type air valves (50 mm to 150 mm).

All air valves mentioned above shall be constructed so that internal working parts which may become necessary for repairs shall be readily accessible, removable, and replaceable without use of special tools and removing the valve from the line. Typical installation of air valves shall be as shown on the Drawings.

(2) References

The following standard is referred to:

JIS B2063 Air Valves for Waterworks.

(3) Single Orifice Type Air Valves (25 mm)

Single orifice type air valves shall be cast iron body and single float actuated air valves with flanged ends. Valves shall be designed and manufactured in accordance with JIS B2063. Working pressure shall be 1.568 MPa.

Valves shall automatically operate so that they will exhaust accumulated air under pressure while the pipe is flowing full of water.

Each valve shall be furnished with bronze casting stop valve and cast iron flange, 80 mm in size.

Valves shall be applied for pipeline 300 mm in diameter and smaller unless otherwise specified.

(4) Double Orifice and Combination Type Air-Valve (50 mm to 150 mm)

Double orifice and combination types shall be cast iron body and double float actuated wir valves with flanged ends. Working pressure or all air valves shall be 1.568 MPa.

Double orifice and combination types shall be designed to automatically operate so that they will:

(a). positively open under internal pressure less than atmospheric pressure to admit air in bulk during pipeline draining operation;
(b). exhaust air in bulk and positively close as water, under low head, fills the body of the valve during filling operation;
(c). not blow shut under high velocity air discharge; and
(d). exhaust accumulated air under pressure while the pipe is flowing full of water.

Each double orifice type air valve shall be furnished with stop valve, same size as air valve.

Combination type air valves shall be furnished with stop valve which shall have flanged ends.

Double orifice type and combination type air valves shall be applied for pipelines 350 mm in diameter and larger unless otherwise specified.

9.3.3.10 FOOT VALVES

Foot valves shall be cast iron body, swing type foot valves with renewable composition disc. Valves shall have flanged ends. Valves 100 mm in diameter and smaller shall be designed for a working pressure of 0.98 MPa. Valves 150 mm in diameter and larger shall be designed for a working pressure of 0.49 MPa.

Valves shall have cast iron strainer and valves, 300 mm in diameter and smaller shall have a valve disc knocking lever with suitable size of stainless steel chain extended to the operation floor as shown on the drawings. A net-flow area through the valve port shall be at least 75% of the area of a circle with a diameter equal to the nominal pipe size. The valve seat shall be designed to ensure positive water tight shut-off at low head pressure.

Disc shall be cast iron and shall have a rubber seat mounted on disc by retaining plate. The retaining plate with bolt and hinge pin shall be Type 304 stainless steel.

9.3.3.11 VALVE OPERATORS

(1) General

Operators shall be capable of seating, unseating and rigidly holding the valve disc in any intermediate position under the maximum design unbalanced head and water velocity noted.

Means for holding the valves in intermediate positions shall be furnished.

The operating mechanism of butterfly valve, plug valve and ball valve operators shall incorporate worm gears of bronze and worms of hardened steel operating in a lubricating bath totally enclosed in a sealed water tight gear case.

All valves shall be equipped with adjustable mechanical stop-limiting devised to prevent over travel of the valve disc in the open or closed position.

Operator housing, supports and connections to the valve shall be designed with a minimum safety factor of five (5) based on the ultimate strength, or three, based on the yield strength, of the material used.

Extension stem for valves shall be galvanized seamless steel pipe conforming to JIS G3454, Carbon Steel Pipes for Pressure Service, STPG 38, Schedule 80 with pinned coupling.

Support housing for extension stem shall be seamless steel pipe specified above, schedule 40 with reinforcing steel ribs if required.

Each rising-stem shall be provided with stem guard. The stem guard shall be galvanized seamless steel pipe specified above, Schedule 40. The guard shall be of sufficient diameter and length to permit full travel of the threaded stem without obstruction. Top of the guard shall be closed galvanized steel cap.

The stem guides shall be so constructed that when properly spaced they will hold the stem in alignment and yet allow it enough play to permit easy operation.

The guides shall be spaced in accordance with the manufacturer's recommendations for each stem size. The guides shall be adjustable with respect to the bracket to provide proper concentric alignment with the stem, and shall be so designed that alignment will be maintained after adjustment. Brackets shall be attached to the wall by sufficient anchor bolts to prevent twisting or sagging under load.

Each floorstand unit shall be provided with a position indicator to show the position of the valve disc at all times. The indicators of rising-stem floorstand and non-rising-stem floorstand shall be attached to the operator and floorstand respectively. The indicator shall read in percent (0 – 100%) with minimum graduation of 5%.

Manual operator shall require an input force of not greater than 178 N pull on either hand wheel or crank. Hand wheels shall be of cast iron, clearly marked with an arrow and the word "open" and "close" cast in relief on the rim. Hand wheel shall be of the spoke type only. Webbed or disc type shall not be used.

Pedestal shall be of cast iron with sufficient section to withstand the full load encountered in the valve operation, maintaining the safety factor specified.

Manually operated buried valves shall be operated by " T " wrenches, from ground level. Two (2) " T "shall be provided with each standard size of operating unit.

Buried butterfly operators shall be of the totally enclosed worm and gear type. They shall have stainless steel input shafts and special seats to prevent corrosion. They shall be rated at leak tightness, Class IP68 or they shall be totally sealed, immersion proof type approved. The worm and gear unit shall be permanently lubricated with grease. A stem nut shall be provided on the input shaft and it shall have a cap to center the valve box used to guide the entrance and location of the operating wrench.

All gate valves buried in the ground shall be provided with suitable heavy pattern valve boxes of proper dimensions to fit over the valve bonnets and to extend to such elevation, at or slightly above the finished ground surface, as directed by the Engineer. The barrel shall be not less than the diameter shown. The upper section shall have a flange at the bottom having sufficient bearing area to prevent settling and shall be completed with covers and shall be adjustable. A cap shall center and guide the entrance and location of the operating wrench.

All operators, whose pipe center line is less than 2.0 meters above the operating level shall be of the hand wheel type, unless noted otherwise.

All operators, whose pipe center line is more than 2.0 meters above the operating level, shall be of the chain operated type with chain sufficiently long to reach to 0.9 meters above the operating level, unless noted otherwise.

(2) Manual Operators

(i) Manual Operators for Gate Valves

Manual operators for gate valves, 500 mm and smaller including resilient-seated gates, NRS type shall be wrench nuts and hand wheels type without gear ratio. OS&Y rising stem type resilient-seated gate valves shall be equipped with hand wheels without gear ratio. Wrench nuts and hand wheels shall be made of cast iron or ductile cast iron. The wrench nut shall be 35 mm square at the base with taper 1 to 20 on each side to top of nut, and 63 mm high. The outside diameter of hand wheels shall be not less than those given in the following Table.

VALVE NOMINAL DIAMETER mm	**MINIMUM OUTSIDE DIAMETER OF HAND WHEEL mm**
50	180
80	180
100	220
125	220
150	220
200	300
250	380
300	380
350	450
400	500
450	530
500	600

(ii) Manual Operators for Butterfly Valves and Ball Valves

Manual operators for butterfly valves and ball valves shall be essentially an integral part of a butterfly valve. The rated torque capability of each operator shall be sufficient to seat, unseat, and rigidly hold in any intermediate position the valve disc it controls under the maximum operating condition. All valves shall be equipped with an adjustable mechanical stop-limiting devices to prevent over-travel of the valve disc or ball in the open and closed positions. Operator housings, supports, and connections to the valve shall be designed with a minimum safety factor of five (5), based on the ultimate strength, or three (3), based on the yield strength, of materials used.

Each manual operator shall have all gearing totally enclosed. Operators shall be designed to produce the required operating torque with a maximum rim pull of 356 N on handwheel or chainwheel operators and a maximum input of 203 N. m on operating wrench nuts. Stop-limiting devices shall be provided in the operators for the open and closed positions. All operator components between the input and these stops shall be designed to withstand, without damage, a rim pull of 890 N for handwheel or chainwheel operators and an input torque of 406 N. m for operating wrench nuts.

All gears operators shall be self-locking and designed to transmit two (2) times the required operator torque without damage to the faces of the gear teeth. Each manual operator shall be equipped with a position indicator which shall read both in percent (0 – 100%) with minimum graduation of 5% and in degrees (0 – 90 degrees) with minimum graduation of 5 degrees. The graduation shall be engraved on operator cover plate.

(iii) Gearing

Gears shall be of ductile iron, steel, or bronze, accurately machines with cut teeth, and smooth running with suitable shafts in bronze sleeve bearings or roller bearings of ample size.

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. For remotely operated valves, the operator shall be supplied with a cast-iron pedestal, machined and drilling to receive the gear housing and drilled for bolting to the operating floor.

(3) Electric Valve Operators

(i) General

Two (2) types of electric valve operators such as Type A, integral control type and Type B, standard type shall be specified hereinafter.

Each type electric valve operator shall be furnished in weather-proof construction. The motor shall operate on 415 volt, 3-phase, 50 Hertz, service for open-close and throttling service.

Each type electric valve, operator shall be mounted by the valve manufacturer, tested and adjusted prior to shipment. All electric valve operators shall be designed and manufactured in accordance with AWWA C540 and shall be Limitorque SMB type or other type approved by the Engineer.

a. Type A Integral Control Type

Electric valve operator, Type A shall be integral control type and shall include, but not be limited to, the electric motor, reversing magnetic starter, limit switches, torque switches, space heaters, valve position potentiometer if specified, push-button station, shop wiring, gear case and a declutch hand wheel to allow manual operation of the valve.

The valve control units shall have pushbutton stations furnished in enclosures suitable for flush panel mounting or field mounting as required. The stations shall include pushbuttons, status lights, and a selector switch all as required.

b. Type B Standard Type

Electric valve operator, Type B shall be standard type and include, but not be limited to, the electric motor, reversing magnetic starter, limit switches, torque switches, space heaters, valve position potentiometer if specified, shop wiring, gear case and a declutch hand wheel to allow manual operation of the valve.

(ii) Electric Valve Operators for Butterfly Valve and Plug Valve

Gear Case shall be of cast iron. Flanges for motor attachment and pedestal attachment shall be integrally cast, fully machines, and template drilled.

Motors for electric valve operator shall be capable of producing not less than 1.5 times the required operator torque.

Any gearing in direct association with the electric motor shall be totally enclosed and shall operate in a lubricant.

Operator shall include an adjustable torque or thrust-limited switch capable of stopping the power to the motor when the valve has reached the stops in the open or closed position or when an obstruction has been encountered in either direction of travel. Torque switches shall be factory set to satisfy the calculated value corresponding to the maximum operating conditions.

Limit switches shall be geared to the drive mechanism and in step at all times whether the unit is operated electrically or manually. The switches shall be of the adjustable type capable of being set to trip at the fully open or fully closed valve positions or at any point between. All electrical inter-connections between limit switches, torque switches, indicator lights, and so forth, shall be factory-wired and ready for operation. All gearing used in connection with limit switches shall be factory-lubricated.

Operator shall be provided with a position indicator to show the position of the valve at all times. The indicator shall read in percent (0 – 100%) with minimum graduation of 5%.

Operator shall be equipped with a handwheel for manual operation. The hand wheel shall be connected so that operation of the motor will not cause the handwheel to rotate and the operation of the handwheel shall not cause the motor rotor to rotate. The handwheel shall be engaged by an exterior lever or an automatic clutch. The action of the lever shall also declutch the motor if there is no device to accomplish this automatically when the power supply to the motor ceases. Should the power return to the motor while the handwheel is in use, the design of the unit shall prevent the power from being transmitted to the handwheel. The handwheel shall require a maximum 356 N on the rim at any point through valve travel seating or unseating load.

An arrow and the word "open" and "close" shall be placed on the handwheel to indicate direction of resultant valve movement. Lettering shall be in the English language.

9.3.3.12 STRAINERS AND SIGHT GLASSES

(1) General

The following strainers and sight glasses shall be specified hereinafter:

(a). U-type strainers
(b). Y-type strainers
(c). Sight glasses.

(2) U-Type Strainers

U-type strainers shall be quick open-and-close type strainers. Strainers shall consist of body, removable body cover plate, mesh cage and yoke with bolt. Strainers shall be constructed so that mesh cage shall be readily accessible, removable, and replaceable without use of special tools and removing the strainer from the line. Removable body cover plate shall have air vent plug and be fixed to the body by means of yoke and bolt. Body shall have drain plug. Mesh cage shall consist of inner mesh cage and outer perforated metal cage. Unless otherwise specified, inner mesh size shall be 40. Mesh cage diameter and length shall conform to the following Table. The strainers shall have flanged ends, and working pressure shall be 0.98 MPa for nominal size 50 mm and smaller and 0.735 MPa for nominal size 65 mm to 150 mm.

NOMINAL SIZE mm	MINIMUM MESH CAGE DIAMETER mm	MINIMUM MESH CAGE LENGTH mm
15	20	50
20	30	75
25	40	85
32	45	90
40	50	100
50	60	120
65	100	160
80	100	160
100	130	200
125	170	260
150	220	320

Unless otherwise specified, body, cover plate and yoke with bolt mesh case shall be Type 316 stainless steel and stainless steel casting. If specified, body, cover plate and yoke with bolt shall be type 304 stainless steel and stainless steel casting or cast-iron, and mesh cage shall be Type 304 stainless steel.

(3) Y-Type Strainers

Y-type strainer shall consist of body, removable body cover plate, mesh cage. Strainers shall be constructed so that mesh cage shall be readily accessible, removable, and replaceable without use of special tools and removing the strainer from the line. Removable body cover plate shall be screwed type for nominal size 50 mm and smaller and flanged type for nominal size 65 mm to 200 mm. Mesh cage shall consist of inner mesh cage and outer perforated metal cage.

Unless otherwise specified, inner mesh size shall be 40. Mesh cage diameter and length shall conform to the following Table. The strainer shall have flanged ends and working pressure shall be 1.568 MPa.

NOMINAL SIZE mm	MINIMUM MESH CAGE DIAMETER mm	MINIMUM MESH CAGE LENGTH mm
15	18	45
20	23	50
25	30	60
32	39	70
40	44	75
50	56	90
65	78	120
80	88	150
100	110	180
125	140	200
150	170	240
200	210	300

Unless otherwise specified, body, cover plate and mesh cage shall be Type 316 stainless steel and stainless steel casting. If specified, body and cover plate shall be Type 304 stainless steel and stainless steel casting or cast-iron, and mesh cage shall be Type 304 stainless steel.

(4) Sight Glasses

Sight glasses shall consist of flanged body and two sight glasses with glass holders. If specified, sight glass shall have colored plastic balls. Working pressure shall be 0.98 MPa.

Body for chemical service and for general purpose shall be Type 316 and 304 stainless steel casting respectively.

9.3.3.13 SLUICE GATES

All work shall be performed in accordance with the best modern practice for the manufacture of high grade machinery.

All parts shall have accurately machined mounting and bearing surfaces so that they can be assembled without fitting, chipping or re-machining. All parts shall conform accurately to the design dimensions and shall be free of all defects in workmanship or material that will impair their service. All attaching bolt holes shall be accurately drilled to the layout indicated on the shop drawings. The sluice gates shall be completely shop assembled to insure the proper fit and adjustment of all parts.

(1) Materials

All materials used in the construction of the gates and appurtenances shall be the best suited for the application and shall be allowable materials under AWWA C5O1 or as noted hereunder.

Frame	- High grade cast iron (according to BS1452)
Door	- High grade cast iron (according to BS1452) designed to withstand seating heads up to 16 meters and 8 meters off-seating
Sealing faces	- Copper alloy sealing faces bedded to 0.1 mm feeler gauge non-acceptance to provide an effective seal (according to BS 2784 CZ121)
Wedges	- High grade cast iron (according to BS 1452)
Thrust housing	- Cast Iron
Door nut	- Gun-metal to BS1400 LG2 for non-rising stem application

(2) Construction

Sluice gates shall be circular aperture, non-rising stem, flush invert and conventional closure type for wall mounting applications. The sluice gates shall consist of frames, door, sealing faces, wedging devices, stems and stem couplings, stem guides and *lifting devices*. All gate components shall be designed to safely withstand the heads to be encountered. Head conditions shall be measured from the bottom of the gate.

(i) Frames

Frames shall be one piece and flat back, flange back or projected back edge around opening type.

(ii) Doors

Slides shall be made in one piece with strengthening ribs where required, and reinforced section to receive the seating faces.

(iii) Sealing Faces

Seating faces shall be secured firmly in frame and slide faces. Average criterion for leakage shall be not more than:

On-seating duty - 1.25 Liters /minute/ seal perimeter for 16 m head.
Off-seating duty - 3.0 Liters/minute/seal perimeter for 8 m head.

(iv) Wedging Devices

Sluice gate shall be equipped with adjustable side-wedging devices to provide contact between the slide and frame facing when the gate is in closed position. Wedges shall be fully adjustable and so designed that they will remain in the fixed position after adjustment.

(v) Stem and Stem Couplings

The operating stems shall be of a size to safely withstand, without buckling or permanent distortion, the stresses induced by normal operating forces. The stems shall be made from solid bar stock of stainless steel. The stems shall be designed to transmit in compression at least two times the rated output of the operator. Where stems are furnished in more than one piece, the different sections shall be joined together by solid couplings.

(vi) Manual Lifting Mechanisms

Manual lifting mechanisms shall be hand wheel operated type and shall be either a single or double gear type with bevel gear box. Manual lifting mechanism shall have a lift nut threaded to fit the operating stem and ball or roller bearings shall be provided above and below the flange on the lift nut to take the thrust developed in opening and closing gate with a torque of 14 kgf.m on the crank or hand wheel.

Gears shall be machined accurately with cut teeth to provide smooth, proper operation for lifting mechanism. Suitable shafts shall be installed with sleeve, ball or roller bearings of appropriate size. All gears and bearings shall be enclosed in housings. Fittings shall be provided so that all gears and bearings can be lubricated periodically.

Lifting mechanism shall be supplied with a cast iron pedestal, machined and drilled to receive the gear housing and drilled for bolting to the operating floor. The mechanism shall be geared in such a manner as to permit the slide operation with an effort of not more than 7 kgf.m on the lifting device after the slide is unseated from its wedges based on the operating head specified.

Crank shall be removable and fitted with a corrosion-resistant rotating handle. The maximum crank radius shall be 380 mm and the maximum hand wheel diameter shall be 760 mm.

The direction of wheel or crank rotation to open the gate shall be indicated on the lift mechanism.

Each non-rising-stem unit shall be provided with a position indicator to show the position of the gate at all times. The indicator shall be attached to the mechanism and shall read in percent (0-100 %) with minimum graduation of 5%.

Pedestal shall be of cast iron with sufficient section to withstand the full load encountered in the gate operation, maintaining the safety factor specified.

(vii) Protective Coating

Protective coating shall be System C as specified in SUB-SECTION 9.1.6 PAINTING & PROTECTIVE COATING, GENERAL SPECIFICATIONS-CIVIL WORKS.

9.3.4 MAJOR PUMPING UNITS

9.3.4.1 GENERAL

(1) Scope of Work

The work specified herein includes the furnishing and installing, in a satisfactory operating condition, electric motor driven pumping units as required by SCHEDULE OF MAJOR PUMPING UNITS, SUB - SECTION 9.4.3 of PARTICULAR SPECIFICATIONS - MECHANICAL WORKS, together with motor control panels and all other necessary and desirable accessory equipment and auxiliaries and appurtenances, whether specifically mentioned in this specification or not, as required for an installation incorporating the highest standards for the type of service, and including field testing of the entire installation and instruction of the regular operating personnel in the care, operation and maintenance of all equipment.

The following types of pumps shall be specified hereinafter.

(a). Double suction volute pumps.

(2) References

The following standards are referred to.

JIS B	1452	Flexible Flanged Shaft Couplings
JIS B	1453	Geared Type Shaft Couplings
JIS B	8301	Testing Methods for Centrifugal Pumps, Mixed Flow Pumps and Axial Flow Pumps
JIS B	8302	Measurement Methods of Pump Discharge
JIS G	4051	Carbon Steels for Machine Structural Use
JIS G	5501	Gray Iron Casting
JIS H	5111	Bronze Castings
ISO	3555	Centrifugal mixed flow and axial pumps-Code for acceptance test - Class B.

(3) Schedule of Major Pumping Units

Schedule of major pumping units will be specified in SUB - SECTION 9.4.3, MAJOR PUMPING UNITS, PARTICULAR SPECIFICATIONS – MECHANICAL WORKS.

(4) General Arrangements

(i) General

The Contractor shall be responsible for the design of the complete electric motor driven pumping units, and shall guarantee the complete units to be free from harmful torsional or other vibration stresses throughout the entire operating range of speed and loads.

(ii) Data Submittal

Literature, pump characteristic curves showing head capacity, horsepower, efficiency and required NPSH, detail drawings including materials, construction and parts list to indicate full conformance with the detail specifications and to show installation details shall be submitted to the Engineer.

(iii) Nameplate

There shall be a metal nameplate on each pump with the serial number, size type or model, design head, capacity and speed stamped into the plate. There shall also be an arrow indicating the direction of forward rotation.

(iv) Shop and Field Painting

The pumps, couplings, motors and bed plates shall have shop and field coats. All interior ferrous and non-machined surface of casings shall be shop painted with tar epoxy paint, Paint System E1 unless otherwise specified.

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

(v) Anchor Bolts

The Contractor shall furnish all anchor bolts and other necessary bolts and nuts for the complete pump installation.

(vi) Materials and Workmanship

All materials shall be of the highest grade, free from defects and imperfections, of recent manufacture and unused, and of the classification and grades designated. Material not specifically described shall conform to the manufacturer's standard for the applicable part in the service intended.

All materials, supplies, and articles, not manufactured by the Contractor, shall be the products of recognized reputable manufacturers. The products of firms other than those specified herein will be accepted when it is proved to the satisfaction of the Engineer that they are equal in strength, durability, usefulness, and convenience for the purpose intended.

The Contractor shall furnish to the Engineer for his approval the names of the manufacturers of all machinery and other equipment which he contemplates incorporating in the work, together with performance capacities and other relevant information pertaining to the equipment. Samples of materials shall be submitted for approval when so directed. Equipment, materials, and articles installed or used without such approval shall be at the risk of subsequent rejection.

Workmanship shall be of the highest grade and in accordance with the best modern standard practice.

Liberal factors of safety shall be used throughout the design and especially in the design of all parts subject to alternating stresses or shock. For pumps, the maximum units stress due to maximum operating conditions shall not exceed the values given in the following table, with the exception of the pump shaft in which the combined torsional and axial stress shall not exceed seven (7) percent of the tensile strength of the material.

Table of Unit Stress (N/mm^2)

	Stress in Tension	Stress in Compression
Cast Iron	14.7	73.5
Plate Steel	88.2	88.2

For other materials used in the construction of the pump, the maximum stressed in tension or compression due to the most severe operating conditions shall not exceed one-third of the yield point or one-fifth of the tensile strength of the material. The maximum unit working stresses in shear shall not exceed 14.7 N/mm^2 in cast iron, nor more than 60 percent of the allowable stresses in tension for other materials.

9.3.4.2 DOUBLE SUCTION VOLUTE PUMPS

(1) General

The pumps shall be single stage, double suction, horizontally split case type, centrifugal pumps suitable for continuous heavy duty service. The construction of the pumps shall be such that no damage will occur to the pump, attached motor or controls if reverse rotation takes place. Mechanical brakes or ratchets shall not be permitted. No non-metallic materials will be allowed in the inside of the pump casing or impellers.

Pump speed, head and capacity characteristics shall conform to the requirement listed in the "SCHEDULE".

Unless otherwise noted, relation between pump suction diameter, 500 mm in diameter and smaller and pole number of the drive motor shall be as specified in the following table.

POLE NUMBER OF DRIVE MOTOR	PUMP SUCTION DIAMETER mm
4	200, 250, 300 and 350
6	300, 350, 400 and 500
8	450 and 500

Rated discharge flow of the pump, suction diameter 500 mm in diameter and smaller shall be as specified in the following Table.

PUMP SUCTION DIAMETER Mm	RATED DISCHARGE FLOW m^3/min
200	2.5 to 5.0
250	4.0 to 8.0
300	6.3 to 12.5
350	8 .0 to 16.0
400	10.0 to 20.0
500	16.0 to 31.5

At any total head between shut-off head and run out head or capacity specified in "SCHEDULE", the required NPSH shall not exceed the available NPSH based on the pump suction piping and suction pool low water elevation indicated on the drawings.

In no case shall the efficiency at the specified rated operation point be less than the value specified in "SCHEDULE".

Pumps of equal head-capacity characteristics shall have identical features of construction and parts shall be interchangeable. Unless otherwise specified, the pump casing design pressure shall be their shut-off pressure plus 10.0 m and the pump casing shall be hydrostatically tested to 150 percent of their casing design pressure. Minimum length of hydrostatic test shall be 3 minutes.

All essential and desirable indicators, lubrication devices, and other accessories for the pumping units shall be provided.

(2) Construction and Materials

(i) Casing

The casing shall be horizontally split on the centerline of the shaft with suctions and discharge connections cast integrally in the lower half to permit removal of the complete rotating element by removal of the upper half casing, the bearing caps, and coupling bolts.

The faces of the upper and lower halves shall be accurately machined and doweled for tight and accurate fit. The bearing brackets shall be cast separately and bolted to the lower half of the casing. The suction and discharge flanges shall conform to the FLANGE SCHEDULE specified in SUB-SECTION 9.3.2 PIPING.

There shall be a 10 mm pipe tap connection in each flange. The upper half of the casing shall be fitted with eyebolts. There shall be at least two (2) 25 mm pipe tap connections, one at the bottom of the lower casing as a drain and the other at the top of the upper casing as an air vent.

Additional tapped connections shall be provided at any other high points in the upper casing. The drain shall be fitted with a gate valve. The top of the upper casing shall be fitted with a gate valve and a priming sight glass with water level detector if required.

Both the exterior and the interior surfaces shall be finished smooth. No plugging, welding, or other repairs to casting will be permitted. The casing shall be of cast iron conforming to JIS G5501, Class 3, FC200 or better. Minimum casing thickness of the pumps, suction diameter, 500 mm and smaller shall be as specified in the following Table.

PUMP SUCTION DIAMETER mm	MINIMUM CASING THICKNESS mm
200	6
250	6
300	8
350	8
400	10
500	12

(ii) Impeller

The impeller shall be of the enclosed double suction type, of one-piece construction, finished smooth, and statically and dynamically balanced. The impeller shall be tightly mounted on the pump shaft with a key so that it will not become loose due to rotation either in the forward or in the reverse direction.

The impeller shall be of bronze casting conforming to JIS H5111, Class 2, BC 2 or better unless otherwise specified. Minimum thickness of impeller, except tip of inlet and outlet of impeller, shall be 4 mm for pumps, suction diameter 300 mm and smaller, and 5mm for pumps, suction diameter 350 mm to 500 mm.

(iii) Wearing Rings

Unless otherwise specified, removable wearing ring shall be provided on the pump casing. If specified, removable wearing rings shall be provided on both of pump casing and impeller. The wearing rings shall be of bronze casting conforming to JIS H5111, Class 6, BC 6 or better.

(iv) Shaft and Sleeves

The pump shafts shall be of heat-treated carbon steel conforming to :

(a). JIS G4051, Class S30C or better, for pumps of suction diameter, 500 mm and smaller

(b). JIS G4051, Class S35C or better for pumps of suction diameter, 600 mm and larger.

The pump shafts shall be ground and polished over the entire length. Shafts shall be of ample size and rigidity to ensure low working stress under all conditions of operation.

For the pumps of suction diameter, 500 mm and smaller, the minimum size of the shaft shall be determined by the following formula.

$$d = K\,(L/n)^{\frac{1}{3}}$$

$$L = 0.163 \times SG \times Q \times H \times 1/EF$$

Where :

d : Minimum shaft diameter of any under cut, mm
L : Required shaft power, kW
n : Pump rotational speed, rpm SG : Specific gravity of handling liquid, 1.0
Q : Rated discharge flow, m3/min
H : Rated head, m
EF :Pump efficiency at rated operation point
K : Co-efficient, K = 125 with shaft materials of JIS G4051, Class S30C. When high class materials will be used, K may be modified based on the following formula and the minimum K shall be 110 with any materials proposed. K = 125 (471/TS)
TS :Tensile strength of proposed material, N/mm^2.

For the pumps of suction diameter 600 mm and larger, the combined shear stresses on the shaft shall not exceed 33 N/mm^2 at the smallest diameter.

The shaft shall be protected from wear and corrosion by removable sleeves. The sleeves shall extend from the impeller to the outside of the stuffing boxes. Sleeves shall be of bronze casting or stainless steel. Bronze casting shall conform to JIS 5111, class 6, BC6 or better. Type of stainless steel shall be 304, 420 or others.

(v) Bearings

The bearings shall be of heavy-duty anti-friction ball, or spherical roller type or sleeve type, or a combination of the two types.

For pumps of suction diameter 500 mm and smaller, lubrication shall be by oil or grease and a direct reading bearing temperature indicator shall be provided on each bearing unless otherwise specified. A suitable guard for each indicator shall be provided.

For the pumps of suction diameter 600 mm and larger, regardless of the type of bearing provided, lubrication shall be by oil. Grease lubrication will not be acceptable. Constant-level oilers 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.

There shall be a water deflector fastened to the shaft at the inner end of each bearing housing.

(vi) Stuffing Boxes

Stuffing boxes shall be large and deep and shall be provided with square packing rings and a lantern ring. Number of square packing rings shall be as specified in the following Table.

PUMP SUCTION DIAMETER	MINIMUM NUMBERS OF SQUARE PACKING RING
500 and smaller	5
600 and larger	6

Packing glands shall be bronze casting conforming to JIS H5111, Class 6, BC 6, split horizontally to provide for installing packing.

Unless otherwise specified, piping with gate valves shall be provided for sealing water to each stuffing box from a tapping on each side of the discharge volute casing.

(vii) Bed Plate

Bed plates shall be fabricated steel or cast iron box with web reinforcing so designed that they can be grouted after alignment and leveling.

(viii) Shaft Coupling

Coupling between pump and drive shall be the flexible type and shall have sufficient capacity to develop the full strength of the shafting which they connect.

For pumps of suction diameter 500 mm and smaller, the shaft coupling shall be a flexible flanged shaft coupling conforming to JIS B1452.

For the pumps of suction diameter 600 mm and larger, the shaft coupling shall be of forged steel and shall transmit torque by means of external gears on hubs engaging internal gears on the coupling sleeves, or by means of a steel grid fitted into grooves in the peripheries of the coupling hubs.

The former shaft coupling mentioned above shall conform to JIS B1453. The couplings shall be enclosed and sealed to retain the lubricant and exclude dust and moisture from the contact surfaces of the torque-transmitting members. Couplings shall be provided with guards.

(ix) Pressure Gauges and Connections

There shall be provided not less than 10 cm diameter pressure gauge for both the suction and discharge side of each pump. The gauge ranges shall be selected such that they will be roughly double the maximum vacuum gauges. The gauges shall have brass case and ring, finish black and phosphor bronze Bourdon tube. The ranges selected shall be submitted to the Engineer for approval. The gauges shall be mounted on a 3.20 millimeter steel panel supported on a free-standing steel angle frame by each pump. The gauges shall have bottom connection with shut-off valves mounted on the front of the gauge panel.

(3) Motors

The motors for the driven pumps shall have sufficient rating to operate the pump at any point on its characteristic curve without overloading and in addition shall have a service factor of at least 1.15 at the rated operation point.

Output of motors shall be not less than kilowatt rating specified in the SCHEDULE.

Unless otherwise specified, motors which are rated at 30 kW and smaller shall be the totally enclosed, fan cooled type and motors of output 37 kW and larger shall be the open drip-proof type. All motors shall be as hereinafter specified under SUB-SECTION 9.5.14, MOTORS, GENERAL SPECIFICATIONS – ELECTRICAL WORKS.

(4) Factory Performance Tests

Unless otherwise specified, all pumps shall be tested at the manufacturer's plant to demonstrate complete compliance with these specifications. The tests shall be in full compliance with the applicable provisions of JIS B8301 and JIS B8302 or ISO 3555, and as herein noted.

Unless waived in writing by the Engineer, all tests shall be witnessed by a duly authorized representative of the Engineer. The Contractor shall provide 30 days notice to the Engineer in writing prior to conducting factory tests.

The tests shall cover the entire range of total head from shut-off to the minimum total head at which the pump can operate without cavitation, noise, or vibration with suction pool water level indicated on the drawings as low water elevation. The minimum head shall be equal to or less than the run out head specified for each pump. Data shall be recorded for not less than five points between shut-off and the minimum total head for suction pool low water elevation. After factory performance tests, the Contractor shall submit six (6) copies of test reports.

If the pump fails to meet the specified head capacity efficiency requirements or indicate cavitation or damaging noise or vibration in the total head range between shut-off and specified run out heads, the pump shall be modified or newly manufactured until acceptable tests are completed.

(5) Installation

The Contractor shall install all pumps specified herein. All handling and placing of the pumps including leveling and alignment shall be done by the Contractor. Final checking of leveling and alignment of each pump shall be done by a supervisor from the pump manufacturer.

(6) Field Tests

As soon as convenient after the equipment is installed, each unit shall be field tested to determine that the units have been properly installed, to verify factory tests, and to demonstrate that the complete units will operate continuously without over heating and that the drives are not overloaded.

The portion of the test to demonstrate satisfactory continuous operation shall be for five (5) continuous hours. During the field test operation the total head shall be as near the condition point total head as conditions at the site will permit.

Reading off all essential data shall be taken and recorded at 30 minute intervals. All instruments required for the readings shall be acceptable calibrated devices furnished by the Contractor at no additional cost to the Employer. Readings required include, but are not limited to, voltage, amperage, power factor, RPM, suction and discharge pressure, flow, temperatures and vibration. Full details of test procedures will be as determined or approved by the Engineer based on conditions existing in the field at the time of the tests. The Contractor shall submit six (6) copies of all results arranged and neatly presented for the approval of the Engineer.

(7) Spare Parts & Tools

The list of spare parts & tools to be furnished by the Contractor as specified in Sub-section 9.3.1.22 shall include but not be limited to the following spare parts & tools for each pump.

a. One (1) Complete set of sleeve
b. One (1) Complete set of bearings
c. One (1) Complete set of wearing rings
d. Two (2)Complete sets of all gaskets
e. Three (3) Complete sets of all packing required for the pump
f. Two (2)Lantern rings
g. Two (2)Complete sets of all special bolts, screws and nuts
h. One (1) Complete set of special tools required for maintenance of the pump

(8) Certification

The Contractor shall submit a certificate to the Engineer from the manufacturer stating that the installation of the equipment is satisfactory; that the units are ready for operation; and that the operating personnel have been suitably instructed in the operation, lubrication and care of the units.

9.3.5 MISCELLANEOUS PUMPING UNITS

9.3.5.1 GENERAL

(1) Scope of Work

Provide all labor, materials, equipment and incidentals necessary to furnish, install and test the miscellaneous pumping units as specified herein and as shown on the drawings.

The following types of pumps shall be specified hereinafter and the units shall be complete with electric motors, or engines, starters, automatic controls where specified or shown, floor plates and all other necessary appurtenances.

a. End Suction Centrifugal Pumps
b. Multi-Stage Centrifugal Pumps
c. Horizontal Peripheral Pumps
d. Vertical Centrifugal Sump Pumps

(2) References

The following standards are referred to:

JIS B1452	Flexible Flanged Shaft Couplings
JIS B1521	Deep Groove Ball Bearings
JIS B1522	Angular Contact Ball Bearings
JIS B1523	Self-aligning Ball Bearings
JIS B1533	Cylindrical Roller Bearings
JIS B8301	Testing Methods for Centrifugal Pumps, Mixed Flow Pumps and Axial Flow Pumps
JIS B8302	Measurement Methods of Pump Discharge
JIS B8303	Testing Methods for Boiler Feed Pumps
JIS B8304	Testing Methods for Condensate Pumps
JIS B8305	Testing Methods for Self-priming Centrifugal Pumps
JIS B8313	End Suction Centrifugal Pumps
JIS B8319	Small Size Multi-Stage Centrifugal Pumps
JIS H5111	Bronze Castings
JIS H5115	Leaded Tin Bronze Castings
JIS G4051	Carbon Steel for Machine Structural Use
JIS G5501	Gray Iron Castings
ISO 2858	End-suction centrifugal pumps (rating 16 bar) - Designation, nominal duty point and dimensions
ISO 3069	End-suction centrifugal pumps - Dimensions of cavities for mechanical seals and for soft packing

(3) Schedule Of Miscellaneous Pumping Units

Schedule of miscellaneous pumping units will be specified in SUB - SECTION 9.4.4, MISCELLANEOUS PUMPING UNITS of the PARTICULAR SPECIFICATIONS-MECHANICAL WORKS.

(4) General Arrangements

(i) Design of Pumps

Pumps shall be designed for the specified performance and shall operate without overheating, excessive vibration, or strain.

All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the work to be done.

(ii) Data Submittal

Literature, pump characteristic curves showing head-capacity, horsepower, efficiency and required NPSH, detail drawings including materials, construction and parts list to indicate full conformance with the detail specifications and to show installation details shall be submitted to the Engineer.

(iii) Nameplate

Brass or stainless steel nameplates giving the name of the manufacturer, the rated capacity, head, speed, model and serial number and other pertinent data shall be attached to each pump.

Similar nameplates giving pertinent motor data shall be attached to each electric motor.

(iv) Shop and Field Painting

The pumps, couplings, motors and bed plates shall have shop and field coats. All interior ferrous and non-machined surface of casings shall be shop painted with tar epoxy paint, either Paint System E1 or E2.

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

(v) Factory Performance Tests

Unless otherwise specified, all pumps shall be tested at the manufacturer's plant to demonstrate complete compliance with these specifications. The tests shall be in full compliance with the applicable provisions of the following standards.

a. JIS B8301,
b. JIS B8302,
c. JIS B8303,
d. JIS B8304 and
e. JIS B8305

Six (6) copies of test data shall be submitted for approval prior to shipment.

(vi) Field Tests

As soon as convenient after the equipment is installed, each pump shall be field tested to determine that the units have been properly installed, to verify factory tests, and to demonstrate that the complete units will operate continuously without over heating and that the drives are not overloaded.

The tests on each unit shall be four (4) continuous hours. During the operation the total head shall be as near the specified head as conditions at the site will permit.

If required, readings of all essential data shall be taken and recorded at minute intervals. All instruments required for the readings shall be furnished by the Contractor at no additional cost.

(vii) Motors

The motors for the driven pumps except horizontal peripheral pumps shall have sufficient rating to operate the pump at any point on its characteristic curve without overloading and in addition shall have a service factor of at least 1.15 at the rated operation point.

The motors for the driven horizontal peripheral pump shall have sufficient rating to operate the pump at any point on its characteristic curve without overloading and in addition shall have a service factor of at least 1.10 at the shutoff point.

Output of motors shall be not less than kilowatt rating specified in the SCHEDULE.

Unless otherwise specified, motors which are rated at 30 kW and smaller shall be the totally enclosed, fan cooled type and motors of output 37 kW and larger shall be the open drip-proof type. All motors shall be as hereinafter specified under SUB-SECTION 9.5.14 MOTORS, GENERAL SPECIFICATIONS – ELECTRICAL WORKS.

(viii) Spare parts & tools & tools and Tools

A list of spare parts & tools & tools shall be furnished as specified in SUB-SECTION 9.3.1.22.

9.3.6 CONVEYING SYSTEM

9.3.6.1 GENERAL

(1) Scope of Work

The Contractor shall furnish all labor, materials, equipment and incidentals required to provide and install and make ready for operation conveying system as required by "SCHEDULE", SUB-SECTION 9.4.5 CONVEYING SYSTEM, PARTICULAR SPECIFICATIONS –MECHANICAL WORKS, and as indicated on the drawings.

The following equipment shall be specified hereinafter.

a. Double beam motorized bridge cranes
b. Single beam motorized bridge cranes
c. Single beam hand-operated bridge cranes
d. Motorized wire hoists
e. Motorized chain hoists
f. Hand-operated chain hoists
g. Miscellaneous systems
   - Gantry "A" frames
   - Jib cranes
   - Portable pulley blocks

(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

(3) Schedule of Conveying System

Schedule of conveying system will be specified in SUB-SECTION 9.4.5 CONVEYING SYSTEM, PARTICULAR SPECIFICATIONS – MECHANICAL WORKS.

(4) General Arrangements

(i) General

Each equipment shall be fabricated by a manufacturer regularly engaged in the production of cranes of similar requirements for at least five (5) years.

The crane shall be of such design and constructed so that it will fit the available space without alteration of the building and without change to the location of the crane rails. Clearances between the crane and building construction shall be not less than the following :

a. Between highest part of crane and lowest member of roof structure 50 mm.

b. Between bridge and trucks and nearest wall or column 40 mm.

The limitations for highest position of hook, hook travel, hook approach to centerline of rail and elevation of lowest part of bridge are shown on the drawings or provided in "SCHEDULE" of SECTION 9.4.5, CONVEYING SYSTEM, PARTICULAR SPECIFICATIONS-MECHANICAL WORKS.

Unless otherwise specified, runway beams and crane rails with stoppers shall be supplied and installed by the Contractor.

(ii) Shop Drawings

Submit for approval complete shop drawings and descriptive literature showing details of fabrication and erection of all material and equipment furnished under this Section.

The shop drawings shall include but not be limited to the following data :

(a). Length of bridge crane span
(b). Overhang of bridge trucks relative to crane rail
(c). Bridge wheel tread diameter and wheel base
(d). Limits of hook travel in relation to walls of structure
(e). Speeds of bridge drive, trolley and hoist
(f). Horsepower, full load amperes and number of motors
(g). Hoist capacity and length of lift
(h). Number and type of hoist brakes
(i). Length of track
(j). Installation of runway beams and crane rails
(k). Electric power supply and wiring
(l). Others

(iii) Installation

All equipment specified herein shall be installed in full accordance with the manufacturer's recommendations, by mechanics skilled in the installation of this type of work, and in addition all motorized bridge cranes and motorized monorail system shall be installed under the supervision of the manufacturer's representative.

(iv) Shop Tests

The manufacturer shall furnish the following shop tests for equipment specified.

a. Motorized bridge crane and motorized monorail system

Load test of 125 % rated load with operation of lifting up and down, travelling and cross travelling, and other tests shall be carried out in accordance with following standard.

a. JIS B 8801,
b. JIS B 8810 and
c. JIS C 9620

b. Hand-operated bridge crane and monorail system

Load test with following rated load with operation of lifting up and down, travelling and cross travelling and other tests shall be executed in accordance with JIS B 8802.

RATED CAPACITY Ton	TEST LOAD Ton
0.5	0.75
1.0	1.50
1.5	2.36
2.0	3.00
3.0	4.75
5.0	7.50
8.0	10.00
10.0	12.50

(v) Field Tests

Upon completion of the equipment, the Engineer may order a full load operating test on the equipment. The Contractor shall furnish the labor and materials required for such tests and shall at his own expense correct defects in the fabrication and erection.

(vi) Shop and Field Painting

All ferrous surfaces requiring painting shall be shop and field coated in accordance with the SUB-SECTION 9.1.6 PAINTING & PROTECTIVE COATING, GENERAL SPECIFICATIONS – CIVIL WORKS.

(vii) Anchor Bolts

The Contractor shall furnish all anchor bolts and other necessary appurtenances for the complete equipment installation. Anchor bolts and appurtenances shall be installed under the supervision of the manufacturer's representative.

(viii) Certification

The Contractor shall submit a certificate from the manufacturer stating that the installation of the equipment is satisfactory, that the unit is ready for operation and that the operating personnel have been suitably instructed in the operation, lubrication and care of the unit.

9.3.6.2 DOUBLE BEAM MOTORIZED BRIDGE CRANES

(1) General

The crane shall be motor operated double girder, travelling bridge crane with motor driven trolley and hoist, controls and all appurtenances necessary to operate the crane.

Design and manufacturing the crane with all structural steel members, welding, mechanical and electrical materials and assemblies of the bridge crane shall conform to JIS B 8801.

Steel to be used for all structural steel member shall be JIS G 3101, Class 2 or better.

All members of the crane shall have a minimum safety factor of 5 based on the ultimate strength of materials. Maximum deflection of the bridge shall be 1/800 of the span with given rated load.

The double beam motorized bridge crane shall be complete, including but not limited to the following.

(2) Construction And Materials

(i) Bridge

The bridge shall be double beam, top running, floor control type with motorized drive, push button control, single travel speed of 10 meters per minute, externally adjusted brake, double flanged induction hardened forged steel wheels with sealed roller bearing, and forged steel shafts.

Rubber type end bumpers shall be provided at each end of the crane girders.

(ii) Hoist Trolley

The hoist trolley shall be top running, floor controlled type with motorized drive, upper and lower limit switches, overload weight trip, double reeving for vertical plumb hook travel with wire rope cable and hook, two (2) independent brake systems (one a rectified D.C., short stroke, low maintenance electric motor brake on a solenoid operated disc brake and one a mechanical load brake or approved equal). The hoist trolley shall have a main hoist and auxiliary hoist. Main hoist shall have two lifting speeds of 2 meters per minute and 1 meter or less per minute. If auxiliary lifting is specified, speed of auxiliary hoist lifting shall be approximately 0.5 meter per minute. Hook shall be swivel type with safety latch. Trolley shall have a single travel speed of 10 meters per minute.

(iii) Rails and Runway Beams

Crane rails shall be of the size recommended by the crane manufacturer. The rails shall be installed with staggered splices, appropriate pairs of anchor bolts with rail clips every 60 cm and a continuous strip of 5 mm neoprene between the rails and the runway beam. Rails shall have sliding splice to provide for expansion joints in concrete.

Heavy duty, high impact, rubber faced bumper stops shall be provided at each end of the runway rails.

Runway beams shall be of a standard steel type I or H beam conforming to JIS G 3192. Maximum deflection of runway beams shall be 1/800 span with given maximum wheel load. The runway beams shall be installed on concrete brackets as shown on the drawings.

(iv) Electric Conductors

The electrical conductor for the runway and bridge shall be PVC enclosed conductor system, 100 ampere vertical mount, safety enclosed conductor. The current collectors shall be made of

reinforced fibber glass plastic and shall have spring loaded carbon brushes maintaining uniform contact pressure with copper conductors with 60 amperes in the runway and 30 amperes in the bridge. All accessories for the proper mounting of conductors and collectors shall also be provided.

(v) Power Supply System for Hoist Trolley

The power supply system for the hoist trolley shall be a heavy duty festooned cross conductor system and shall be designed to store cabtyre cable in uniform scallops. Messenger wire or guide bar and cable hanger with accessories shall be stainless steel.

(vi) Controls

The controls shall be an eight (8) button pendant with a dust tight case, ballast resistor speed control and a pilot circuit to reduce the voltage at the push button to 24 volts. The pendant shall be suspended from a festoon roller track on the bridge.

(vii) Cable Reel

The cable reel shall have the electro-magnetic spring pressure multiple disc brake steeples height adjustment and shall be capable of lifting 14 meters of cable pulse pendant and storing 12 meters of pendant cable. Total pendant cable length shall be 14.0 meters.

The cable shall be wound onto the drum of cable reel by means of depressing a button of pendant and shall be drawn down manually.

(viii) Platform

Steel platforms shall be provided at each end of the crane and a connecting steel walkway along the girder with tubular handrails. Suitable gate shall be provided to provide access to the platform from the fixed wall ladder.

9.3.6.3 SINGLE BEAM MOTORIZED BRIDGE CRANES

(1) General

The crane shall be a motor operated single girder, overhead or underhung travelling bridge crane with motorized trolley and hoist, controls and all appurtenances necessary to operate the crane.

Design and manufacturing the crane with all structural steel members, welding, mechanical and electrical materials and assemblies of the bridge crane shall conform to JIS B 8801 and JIS C 9620.

Steel to be used for all structural steel members shall be JIS G 3101, Class 2 or better.

All members of the crane shall have a minimum safety factor of 5 based on the ultimate strength of materials. Maximum deflection of the bridge shall be 1/1000 of the span with given rated load.

The single beam motorized bridge crane shall be complete, including but not limited to the following.

(2) Construction And Materials

(i) Bridge

The bridge shall consist of steel girder carried by end trucks. The girder shall be designed to safely carry the full rated load and proportioned to resist all vertical, lateral and torsional forces within conservative limits. End trucks shall be built up from structural shapes and plates welded to form a rigid section. Trucks shall be precision bored to provide accurate alignments of wheel bearing assemblies. Wheels shall be finished to equal diameters in pairs and be double flanged hardened forged steel etc. Single travel speed of 10 meter per minute shall be provided. Each wheel shall be provided with anti-friction bearings and a sealed self-lubrication system.

(ii) Bridge Drive

Each end truck shall be provided with the bridge drive unit having a completely sealed reduction gear and brake motor. The bridge drive shall be designed to ensure a smooth start and sudden stop and all gearing shall be totally enclosed and in an oil bath.

Rubber type end bumpers shall be provided at each end of the end trucks.

(iii) Motorized Trolley and Wire Hoist

Motorized trolley and wire hoist unit shall be low head type or normal head type specified in SCHEDULE of the SUB-SECTION 9.4.5, CONVEYING SYSTEM, PARTICULAR SPECIFICATIONS – MECHANICL WORKS, and shall be designed and manufactured in accordance with JIS C 9620.

The trolleys shall have motorized drive, single speed specified in the "SCHEDULE", push button control, four flanged induction hardened forged steel wheels with sealed ball or tapered roller bearing, thrust brake and forged steel fittings.

The hoists shall have a lift as required in "SCHEDULE" or on the drawings, motorized drive, single speed or dual speed as specified in the "SCHEDULE", upper and lower limit switches, push button control, two independent brake systems (one a solenoid operated motor brake and one a mechanical load brake, or approved equal), double revving for plumb vertical movement of hook with wire cable and swivel safety latch hook.

(iv) Rails and Runway Beams

a. Overhead Travelling Bridge Type

Crane rails shall be of the size recommended by the crane manufacturer. The rails shall be installed with staggered splices, appropriate pairs of anchor bolts with rail clips every 60 cm and a continuous strip of 5 mm neoprene between the rails and the runway beam. Rails and runway beams shall have sliding splice to provide for expansion joints in concrete structure.

Heavy duty, high impact, rubber faced bumper stops shall be provided at each end of the runway rails.

Runway beams shall be of a standard type I steel or H beam conforming to JIS G 3192. Maximum deflection of runway beams shall be 1/1000 span with given maximum wheel load. The runway beams shall be installed on concrete brackets as shown on the drawings.

b. Underhung Travelling Bridge Type

Crane rails shall be a standard I beam conforming to JIS G 3192 with non-peening rolling surface and maximum deflection of 1/1000 span with given maximum wheel load.

Rails shall be installed in a structural concrete beam in an appropriate manner. Heavy duty, high impact, rubber faced bumper stops shall be provided at each end of the rails.

(v) Electric Conductors

The electrical conductor for the runway and bridge shall be a PVC enclosed conductor system, 100 ampere vertical mount, safety enclosed conductor. The current collectors shall be made of reinforced fiber glass plastic and shall have spring loaded carbon brushes maintaining uniform contact pressure with copper conductors with 60 amperes in the runway and 30 amperes in the bridge. All accessories for the proper mounting of conductors and collectors shall also be provided.

(vi) Power Supply System for Motorized Trolley and Hoist

The power supply system for motorized trolley and hoist shall be a heavy duty festooned cross conductor system and shall be designed to store cabtyre cable in uniform scallops. Messenger wire or guide rail and cable hanger with accessories shall be stainless steel. All accessories for proper mounting of the festooned conductor system shall be provided.

(vii) Controls

The controls shall be push button pendant with a dust tight case, ballast resistor speed control and a pilot circuit to reduce the voltage at the push button to 24 volts. The pendant shall be suspended from the motorized Trolley and hoist to the elevation indicated on the drawings.

9.3.6.4 SINGLE BEAM HAND-OPERATED BRIDGE CRANES

(1) General

The crane shall be a hand-operated single girder, overhead or underhung travelling bridge crane with hand-operated geared trolley type chain hoist.

Design and manufacturing the crane with all structural steel members, welding, mechanical and assemblies of the bridge crane shall conform to JIS B 8801 and JIS B 8802.

Steel to be used for all structural steel member shall be JIS G 3101, Class 2 or better.

All members of the crane shall have a minimum safety factor of 5 based on ultimate strength of materials. Maximum deflection of the bridge shall be 1/800 of the span with given rated load.

(2) Construction and Materials

(i) Bridge and Bridge Drive

The bridge shall consist of steel girder carried by end trucks. The girder shall be designed to safely carry full rated load and proportioned to resist all vertical, lateral and torsional forces within conservative limits. End trucks shall be built up from structural shapes and plates welded to form a

rigid section. Trucks shall be precision bored to provide accurate alignment of wheel bearing assemblies. Wheels shall be finished to equal diameters in pairs and shall be double flanged hardened forged steel wheels. Each wheel shall be provided with anti-friction bearings and a sealed self-lubrication system.

The bridge shall be driven by pulling on an endless hand chain. The hand chain wheel shall be secured to a cross shaft which shall rotate the driving wheels through gear drive or dual belt drive arrangement at each end truck.

(ii) Trolley and Hoist

The geared trolley shall be gear drive type with 4 ball-bearing pressed steel wheels, equipped with life-time lubrication and hardened threads with a geared travel mechanism. Chain hoist shall have a malleable iron casting forming the body casing and main frame. The reduction gears shall provide a positive drive between the driving shaft and the load. The chain hoist shall be manufactured in accordance with JIS B 8802 and shall conform to the requirements specified following SUB-SECTION 9.3.6.5, HAND-OPERATED CHAIN HOIST.

(iii) Rails and Runway Beams

Rails and runway beams shall conform to the requirements as specified in the previous sub-section Rails and Runway Beams, Section 9.3.6.3(2)(iv) of SINGLE BEAM MOTORIZED BRIDGE CRANES.

9.3.6.5 HAND-OPERATED CHAIN HOISTS

(1) General

Hand-operated chain hoist shall be plain or geared trolley with chain hoist. Design load and lifts shall be specified in SCHEDULE of the SUB-SECTION 9.4.5, CONVEYING SYSTEM, PARTICULAR SPECIFICATIONS – MECHANICAL WORKS or on the drawings.

(2) Construction and Materials

Chain hoist shall consist of frame, casing, reduction gear and flanged load sheave with precision roller bearings, load and operation chain, overload limiter, mechanical brake and safety latch hook.

The reduction gears shall be ample proportion and provide a positive drive between the driving shaft and the load. Pinions and spur wheels shall be made from high-grade heat-treated alloy steel and have precision machine cut-teeth.

The brake shall be of the screw and disc type where the brake pressure and the sustaining power increase in proportion to the load on the hook. Screwed brake sleeve shall be high grade steel and mounted on a splined driving shaft.

All chains shall be electrically welded steel, heat treated, polished and accurate to pitch. Dimensions and strength of the chains shall conform to JIS B 8812.

The geared trolley shall be the gear drive type with 4 ball-bearing pressed steel wheels, equipped with life-time lubrication and hardened threads with a geared travel mechanism.

The push and plain trolley shall be of the hung-in travelling type with a forged steel bar held between the side plates of the trolley. The push and plain trolley shall have 4 ball-bearings pressed steel wheels equipped with lifetime lubrication.

Monorail truck shall be a standard I beam conforming to JIS G 3192 with non-penning rolling surface and maximum deflection of 1/1000 span with given maximum wheel load. Heavy duty, high import rubber faced bumper stops shall be provided at each end of truck.

9.3.7 VENTILATION SYSTEM

9.3.7.1 GENERAL

(1) Scope of Work

Provide all labor, materials, equipment and incidentals necessary to furnish and install the ventilating systems complete as shown on the drawings and specified herein. The work includes all supply air fans, except those supplying conditioned (cooled) air, all exhaust fans, all ductwork connected with the supply and exhaust fans, louvers, hangers, electric wiring and support.

The following types of fans shall be specified hereinafter and the fans shall be complete with electric motor, louver or automatic louver where specified and all other necessary appurtenances.

a. Propeller fans
b. Roof fans

(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

(3) Schedule of Ventilating System

Schedule of ventilating system will be specified in SUB-SECTION 9.4.6, VENTILATING SYSTEM, PARTICULAR SPECIFICATIONS – MECHANICAL WORKS.

(4) General Arrangements

(i) General

The contract drawings indicate the extent and general arrangement of the ventilating systems. The Contractor shall be responsible for installing the proposed system as indicated, without violation of specification requirements. Except where dimensions are shown to locate ductwork or equipment, the drawings show duct size and arrangement only. Equipment and ductwork arrangements shall fit into the space as indicated, and shall allow adequate and approved clearances for entry, servicing and maintenance.

(ii) Data Submittal

Literature and shop drawings, describing each item of equipment, shall be submitted to the Engineer for approval. The literature and shop drawings shall include sufficient descriptive materials such as catalogs, cuts, diagrams and other data published by the manufacturer, to demonstrate conformance with requirements of the Contract Documents.

(iii) Capacity

Capacities of equipment and materials shall be not less than those indicated.

(iv) Name Plates

Each major item of equipment shall have the manufacturer's name, address, serial and model number on a plate securely attached to the item.

(v) Safety Requirements

Belts, pulleys, chains, gears, couplings, projecting set-screws, keys, and other rotating parts, so located that personnel can come in close proximity thereto, shall be fully enclosed or properly guarded.

(vi) Verification of Dimensions

The Contractor shall visit the premises to thoroughly familiarize himself with all details of the work and working conditions and verify all dimensions in the field. The Contractor shall be specifically responsible for the coordination and proper relation of his work to the building structure.

(vii) Materials and Equipment

Materials and equipment shall conform to the requirements specified herein and as shown on the drawings and shall be the products of manufacturers regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least five (5) years. Where more than one unit of same capacity is required they shall be the same model with all parts interchangeable.

(viii) Factory Performance Tests

Unless otherwise specified, all fans shall be tested at the manufacturer's plant to demonstrate complete compliance with these specifications. Six (6) copies of test data including flow and pressure characteristic curve, required power, current and others shall be submitted for approval prior to shipment.

(ix) Field Tests

Upon completion, and prior to acceptance of the installation, the Contractor shall subject the ventilating systems to such operating tests as may be required by the Engineer to demonstrate satisfactory functional and operating efficiency. Operating tests shall cover a period of not less than six (6) hours for each system, and all tests shall be conducted at such times as the Engineer may direct. If tests do not demonstrate satisfactory operation of the ventilating systems, deficiencies shall be corrected and tested. All instruments, facilities, and labor required to properly conduct the tests shall be provided by the Contractor.

(x) Motors

Unless otherwise specified, motors shall be totally enclosed, fan cooled type. All motors shall be as hereinafter specified under SUB-SECTION 9.5.14 MOTORS, GENERAL SPECIFICATIONS – ELECTRICAL WORKS.

9.3.7.2 PROPELLER FANS

Propeller fans shall be supply or exhaust and high pressure industrial types. Fan shall be three blade type and blades shall be designed to ensure low noise, high volume of air flow and high efficiency. Fan shall be directly coupled with motor and fan and motor shall be supported by heavy metal frames.

Fan shall be fabricated from steel sheets conforming to JIS G 3141, Class SPCC or aluminium alloy sheets conforming to JIS H 4000, Class A 5052 P. Frame shall be fabricated from steel sheets specified above. When anti-acid type will be specified in the SCHEDULE, fan, frame, shaft, bolts and nuts, and other major parts shall be of Type 304 stainless steel.

Unless otherwise specified, automatic louvers shall be provided with all propeller fans. An automatic louver shall be gravity shutters and shall be factory fabricated, parallel-blade type delicately balanced blades that open automatically when the fan starts and close by gravity when fan stops. The louver blades shall be fabricated from aluminium sheets. The edges of the blades shall be provided with felt or rubber strips to prevent rattling. Louver blades shall be supported on aluminium frames and shall be connected to a vertical bar so all blades open equally.

When specified in the SCHEDULE, fixed louvers or outdoor rain hoods shall be provided. Fixed louvers shall be parallel-blade type and fabricated from aluminium sheets. Outdoor rain hoods shall be of Type 304 stainless steel and shall have enough opening area.

Automatic louvers, fixed louvers and outdoor rain hoods shall be supplied by the same manufacturer as that of fans unless otherwise specified.

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with epoxy resin paint of manufacturer's standard.

Factory performance tests for propeller fans specified shall be executed in accordance with JIS B 8330 or other standards approved by the Engineer.

9.3.7.3 ROOF FANS

Roof fans shall be specially designed for installation on building roof and shall be exhaust type unless otherwise specified.

Roof fans shall consist of body frame, guard net, fan motor unit and top hood. The body frame and top hood shall be designed to have optimum spacing for air flow and to ensure high efficiency. The top hood shall be hinged, swing open type for easy maintenance, and shall have reverse flow prevention flaps and anti-resonant vibration bar. The body frame shall have a square bottom with installation foot.

Fan shall be designed to have deeply twisted blades, and to ensure high volume air flow at high static pressure and high efficiency. Fan shall be directly coupled with motor, and fan and motor shall be supported by heavy metal support unit. Fan motor unit shall be bolted to the body frame and shall be designed to be easily dismantled from the body frame.

The body frame and top hood shall be fabricated from steel sheets conforming to JIS G 3141, Class SPCC. Minimum thickness of sheet for the body frame and top hood shall be 1.6 mm and 1.2 mm respectively. Fan shall be fabricated from steel sheets as specified above or aluminium alloy sheets conforming to JIS H 4000, Class A 5052 P.

Equipment and component items, when fabricated from ferrous metal, shall be finished with epoxy resin paint of manufacturer's standard or hot-dipped galvanizing except that parts exposed outside shall have shop coats of "Paint System A1", alkyd resin paint system as specified in the SUB-SECTION 9.1.6 PAINTING AND PROTECTIVE COATING GENERAL SPECIFICATIONS – CIVIL WORKS.