MATERIAL AND EQUIPMENT STANDARD

FOR

FIRE WATER PUMPS

CONTENTS :

PAGE No.

1. SCOPE

1.1 This standard specification covers the minimum requirements for centrifugal fire water pumps complete with drivers, controllers,and accessories for use in water supply systems for fire fighting services. They are intended to be used in refinery services, chemical plants, petrochemical plants, gas plants and where applicable in exploration, production and new ventures.

1.2 Pumps covered by this standard are intended to be installed and used in accordance with the National Fire Protection Association std. NFPA No. 20 latest edition."Standard for the Installation of Centrifugal Fire Pumps".

1.3 Compliance by the pump vendor with the provisions of this standard dose not relieve him of the responsibility of furnishing pumps and other equipments of proper design, mechanically suited to meet operating guarantees at the specified service condition.

1.4 No deviations or exceptions from this standard shall be permitted, without explicit approval of the company. Intended deviations shall be separately listed by the vendor, supported by reasons thereof and submitted for company's consideration.

1.5 The pump, driver and controls shall be UL and FM listed and approved.

2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The edition of these standards and codes that are in effect at the time of publication of this standard shall, to the extent specified herein, form a part of this standard. The applicability of changes in standards and codes that occur after the date of this standard shall be mutually agreed upon by the Company and the Vendor/ Consultant.

IPS(IRANIAN PETROLEUM STANDARD)

E-SF-900	"Vibration and Noise Control"
M-EL-132	"Induction Motors"
M-PM-240	"General Purpose Steam Turbines "
M-PM-290	"Internal Combustion Reciprocating Engines"

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

B2.1	"Pipe Threads (Except Dry Seal) "
B4.1	"Preferred Limits and Fits for Cylindrical Parts"
B16.1	"Cast iron Pipe Flanges and Flanged Fittings .
B16.5	"Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys"
S2.19	"Balance Quality of Rotating Rigid Bodies"

ANSI /AFBMA (ANTI FRICTION BEARING MANUFACTURER ASSOCIATION)

9	"Load Rating and Fatigue Life for Ball Bearings "
11	"Load Rating and Fatigue Life for Roller Bearings"

NFPA (NATIONAL FIRE PROTECTION ASSOCIATION)

No. 20 "Standard for the Installation of Centrifugal Fire Pumps"

3. CONFLICTING REQUIREMENTS

In case of conflict between this standard, data sheet and purchase order following priority of documents (whichever more stringent realized by company) shall govern.

a) purchase order and variations there to

b) data sheet

c) this standard

All conflicting requirements shall be referred to the purchaser in writing. The purchaser will issue confirmation document if needed for clarification.

4. UNITS

The International System of Units (SI) shall be used, unless otherwise specified.

5. DEFINITIONS AND TERMINOLOGY

For the purpose of this standard, the following definitions in addition to terms defined in NFPA No.20 1990 edition apply:

MAXIMUM WORKING PRESSURE;

For performance tests specified in this standard, the sum of the maximum net pressure developed by the pump and the maximum positive suction pressure marked on the pump, under any condition of intended use. For production tests, this value may be lower, based on the conditions imposed by the particular installation for which the pump is constructed. Therefore, the values of maximum net pressure and maximum positive suction pressure that are marked on the pump are those that indicate the acceptability of a pump (the limiting pressures) for an installation.

SHUTOFF PRESSURE (CHURN);

The net head developed by a pump at rated speed with no water being delivered (discharge valve closed).

PUMP LOAD ;

The brake horsepower (kW output) required to drive a pump at rated speed and at the capacity requiring maximum power.

DIAMETER NOMINAL;

The international nomenclature diameter nominal, written as DN 15,25,40,50,etc., in accordance with appendix B. of this standard shall be used for pipe sizes.

PRESSURE NOMINAL;

The international nomenclature pressure nominal written as PN 20,50,68,etc. in accordance with appendix C. of this standard, shall be used for flange ratings.

6. CONSTRUCTION

6.1 General

6.1.1 An end suction or in-line pump shall be of a single-stage construction. A horizontal_split case pump may be of a single-stage or multistage construction. A vertical-turbine pump may have any number of bowls and impellers.

6.1.2 A horizontal_split case or vertical-turbine pump shall have a rated capacity equal to or greater than a value specified in Table 6.1

TABLE 6.1 PUMP CAPACITIES

GALLONS PER MINUTE	(LITERS PER MINUTE)	GALLONS PER MINUTE	(LITERS PER MINUTE)
25	(95)	2000	(7570)
50	(189)	2500	(9462)
100	(379)	3000	(11355)
150	(568)	3500	(13247)
200	(575)	4000	(15140)
250	(946)	4500	(17032)
300	(1135)	5000	(18925)
400	(1514)		
450	(1703)		
500	(1892)		
750	(2839)		
1000	(3785)		
1250	(4731)		
1500	(5677)		

An end suction or in-line pump shall have a rated capacity of less than 1892 l/min. (500 GPM).

6.1.3 Pump units shall be capable of specified discharge capacities and heads when operating at the specified conditions, water temperatures and densities as listed in the pump data sheets. The vendor shall select a pump with the operating point close to the peak efficiency on the pump performance curve. Pump units shall not overload the driver at any point along the head capacity curve from shut off head to maximum capacity for the impeller provided. At rated conditions, as given in the data sheets and at maximum horsepower along the pump curve, the horsepower requirements shall not exceed the continuous duty nameplate rating of the driver.

6.1.4 All equipments will be located indoors, unless specified otherwise, building will be heated if specified.

6.1.5 Equipment trains shall comply with sound pressure limits and measurements specified in IPS-E-SF-900 " Vibration and Noise Control"

6.1.6 A bolt, stud screw, or gland swing bolt used to assemble parts subject to stress due to water pressure shall not be less than 9.5 mm (3/8 inch)in diameter.

6.1.7 An interior bolt or screw that is exposed to corrosion shall be of corrosion resistant material.

6.1.8 The maximum stress on any bolt of a pressure-holding casting shall not exceed one-fourth the elastic limit of the material as computed by using the stress area. The stress area is defined by the equation:

$$A_s = 0.7854 \left(D - \frac{0.9743}{n} \right)^2$$

in which:

A_s is the stress area in square inches ($m^2 \times 1550$).

D is the nominal diameter of bolt in inches (mm × 0.04), and

n is the number of threads per inch (25.4 mm).

The load on the bolts is to be computed on the basis of the water pressure equivalent to the shutoff pressure effective over the area out to the centerline of the bolts.

6.1.9 Flange dimensions and bolt layouts used in pipe connections shall comply with the requirements of ANSI B16.1 and B16.5, latest edition.

6.1.10 A threaded opening used for pipe connection shall comply with the requirements in the Standard for Pipe Threads (Except Dry Seal), ANSI B2.1 latest edition.

6.1.11 All pumps of the same rating shall be identical and all component parts of the same end function shall be interchangeable. Maximum practicable use shall be made of interchangeable component parts and hardware.

6.2 Horizontal Split-Case, End-Suction, and in-Line Pumps

6.2.1 Pump Casing

6.2.1.1 The pump casing shall be constructed to permit examination of impellers and other interior parts without disturbing suction or discharge piping. The casing shall include means to facilitate disassembly of the casing, and the stuffing box cover (if provided),without requiring the use of wedges or prying elements, such as by provision of tapped holes for jackscrews.

6.2.1.2 A suction opening and discharge opening in the pump casing shall not be less than the dimensions specified in Table 6.2 . These dimensions shall be provided in the casing construction or by attachment of special castings to the pump casing.

TABLE 6.2 SIZE OF OPENINGS FOR PUMPS

PUMP RATING		NOMINAL DIAMETER, mm	
GALLONS PER MINUTE	(LITERS PER MINUTE)	SUCTION	DISCHARGE
25	(95)	25	25
50	(189)	40	32
100	(379)	50	50
150	(568)	65	65
200	(757)	75	75
250	(946)	90	75
300	(1135)	100	100
400	(1514)	100	100
450	(1703)	125	125
500	(1892)	125	125
750	(2839)	150	150
1000	(3785)	200	150
1250	(4731)	200	200
1500	(5677)	200	200
2000	(7570)	250	250
2500	(9462)	250	250
3000	(11355)	300	300
3500	(13247)	300	300
4000	(15140)	350	300
4500	(17032)	400	350
5000	(18925)	400	350

6.2.1.3 The pump shall be provided with baseplate or sole plate for support. The support means shall have structural strength and rigidity acceptable for the application.

6.2.1.4 A drain opening shall be provided so that all parts of the pump casing can be drained. The opening shall be threaded to receive a plug that is (1) not smaller than DN 15 mm and (2) formed of corrosion resistant material.

6.2.3 Impellers, Rings and other Internal Components

6.2.3.1 A pump shall be provided with wearing rings that are made of material that will not gall. The rings shall be secured in a manner that will not permit rotational or axial movement.

A diffusion vane casting may be protected against corrosion and sticking by broze-tipping the portion most exposed.

6.2.3.2 Impeller,impeller wearing rings, case wearing rings, guide or diffusion vane rings, lantern rings, stuffing-box bottoms, interior nuts, linings of stuffing-box throats glands, gland nuts, and drain plugs shall be of corrosion resistant material.

6.2.3.3 The minimum dimensions of the passages at the periphery or any point in the impeller shall not be less than (1) 7.9 mm (5/16 inch) for a pump rated 1892 L/min. (500 GPM), (2) 12.7 mm (1/2 inch) for a pump rated more than 1892 L/min but not more than 2839 L/min (750 GPM) and (3) 15.9 mm (5/8 inch) for a pump rated more than 2839 L/min.

6.2.3.4 The radial clearance between a stationary and moving part of a pump shall not be less than 0.191 min.

6.2.3.5 The impellers shall be secured in an axial direction, permitting no contact with the casing under operating conditions.

6.2.3.6 Unless otherwise specified, the impellers shall be of the closed type; that is , they shall incorporate shrouds or sidewalls that completely enclose the impeller waterways from the suction eye to the periphery.

6.2.3.7 The impellers shall be dynamically balanced to the G6.3 balance quality grade in accordance with the requirements for pump impellers in the Standard for Balance Quality of Rotating Rigid Bodies, ANSI S2.19 1975 (R1986).

Exception:

The impellers may be statically balanced in accordance with ANSI S2.19 if the ratio of the maximum outside diameter to the width at the periphery (including the shroud but not including the back vane) is equal to or greater than 6.

6.2.4 Shafts

Shafts shall be adequately sized to withstand loads imposed by continuous operation at any point throughout the pump curve range, plus allowance for ample safety factor. The maximum combined shear stress for a pump shaft shall not exceed 30 percent of the elastic limit in tension or be more than 18 percent of the ultimate tensile strength of the shafting steel used. Compliance with this requirement is to be verified by a review of manufacturers' stress calculations. Pump shafts shall be machined and accurately ground.

6.2.5 Bearings

6.2.5.1 Sleeve bearings

6.2.5.1.1 The main shaft bearings shall be proportioned so that the stress on the projected area of any bearing will not be more than 138 kPa (20 psi).

6.2.5.1.2 Each bearing shall be of the removable-shell type. Each shell shall be lined throughout. The finished bearing shall not be less than 6.4 mm thick (1/4 inch).

6.2.5.1.3 The removable shells shall be accurately machined to uniform cylindrical fits and shall be interchangeable.

6.2.5.1.4 Oil grooves that lubricate the entire bearing shall be provided.

6.2.5.1.5 Each bearing shall be provided with a ring or endless-chain oiler, its lower part running in an oil-filled chamber cast under the bearings. This chamber shall be provided with a DN 15 mm nominal diameter pipe drain hole fitted with a brass plug.

6.2.5.1.6 Each bearing cap shall be provided with a hinged lid large enough to permit application of oil and inspection of the bearing.

6.2.5.1.7 Water slingers of corrosion-resistant material shall be provided to seal the bearing at their inner ends. Dust caps shall be provided to seal the bearings at their outer ends.

6.2.5.2 Ball and roller bearing

6.2.5.2.1 Ball and roller bearings shall have an L - 10 rating of not less than 5000 hours at maximum load (maximum hydraulic load on the largest impeller operated at any point on its rated speed curve) in accordance with the standard for Load Ratings and Fatigue Life for Ball Bearings, ANSI/AFBMA 9-1978(R1986) ,and Load Ratings and Fatigue Life for Roller Bearings. ANSI/AFBMA 11-1978 (R1986), respectively.

6.2.5.2.2 With reference to paragraph 6.5.2.1 the L-10 rating in hours is to be calculated from the L-10 rating in revolutions based on the following equation:

$$L_h = \frac{L_{10}}{N¢\ 60}$$

in which:

$$L_{10} = \frac{C^3}{P^3} = \frac{C^3}{(XF_r + YF_a)^3}$$

$$L_{10} = \frac{C^{10=3}}{p^{10=3}} = \frac{C^{10=3}}{(XF_r + YF_a)^{10=3}}$$

and:

L_h is the L-10 rating in hours,

L_{10} is the L-10 rating in revolutions,

N is the rated speed in revolutions per minute,

C is the dynamic load rating of bearing in pounds-force,

P is the combined force on bearing in pounds,

X is the radial load factor of bearing,

F_r is the radial load on bearing in pounds-force,

Y is the axial load factor of bearing, and

F_a is the axial load on bearing in pounds-force

6.2.5.2.3 The bearing assembly on one end of a split-case-pump shaft shall be arranged to float axially. Two bearing assemblies shall be provided for an end-suction pump; one that is free to float within the frame to carry radial forces, and the other arranged to carry both radial and axial thrust. The bearings shall be lubricated with grease.

6.2.5.2.4 Bearings and their races shall be hardened throughout.

6.2.5.2.5 Means, such as water slingers and dust caps, shall be provided to limit the entrance of water or foreign matter to the bearings.

6.2.6 Seals

6.2.6.1 Unless otherwise specified the shaft shall be provided with a stuffing box and packing. A stuffing box shall have a depth of at least five times the width of the packing plus seal cage. The glands shall exert a uniform pressure on the packing. The stuffing box on the suction end of a pump shall be water-sealed at a suction pressure of 207 kPa (20 psig) or less. A stuffing box bottom ring, if used, shall be of a corrosion-resistant material.

6.2.6.2 Packing shall not be utilized as bearing supports for the shaft.

6.2.7 Couplings

6.2.7.1 The motor driven pump shall be direct connected to its driver by a flexible coupling as specified on the individual pump data sheet.

6.2.7.2 All metal, spacer type couplings shall be furnished and mounted by the pump vendor. Horizontal pumps shall have flexible couplings. vertical pump may have flexible or rigid couplings.

6.2.7.3 The coupling shall be dynamically balanced when the coupling size speed relationship is such that balancing is recommended by the coupling vendor or indicated in the pump data sheets.

6.2.7.4 Couplings shall be mounted on shafts with cylindrical fit and keyed in place. cylinder fits shall conform to ANSI B4.1 class FN-1.

6.2.7.5 Stubshaft shall be flange mounted on the engine flywheel to accommodate drive half of flexible coupling.

6.2.7.6 Removable all metal, nonsparking guards shall be supplied and mounted. Guards shall be sufficiently heavy and rigid in design to avoid contact with coupling or shaft as result of bodily contact. Vertical pumps shall be provided with removable or hinged wire mesh or sheet metal coupling guards.

6.2.8 Baseplate and Mounting

6.2.8.1 Each pump with driver shall be mounted on the manufacturer's standard support plate. Horizontal drivers shall be mounted on a separate drain rim type baseplate. The baseplate shall be of sturdy cast iron or fabricated steel construction. The base plate shall be provided with adequate accurately drilled holes for anchor bolts.

6.2.8.2 Basic requirements for baseplates for horizontal equipment are as follows:

a) No component of the unit (or accessories) may overhang the drained baseplate area except the motor conduit box.

b) Baseplate shall have a full metal deck with provisions for complete drainage through a DN 25 drain connection at the pump and edge of the baseplate.

c) Minimum of two 100 mm grout holes, with raised lips to prevent liquid accumulation over the grout, and sufficient vents for complete grout, distribution, arranged to allow for grouting with all components in place. Where practical 150 mm grout holes are preferred.

d) Pump and driver support pads shall be machined flat and in the same plane. Driver support pads shall be machined to have 5 mm (minimum) shim space available.

e) Horizontal jack screws (or purchaser authorized alternative) shall be provided to achieve horizontal alignment on all baseplates for drivers excess of 900 kg.

6.2.8.3 Each pump with vertical driver or right angle gear shall be mounted on the pump Vendor's standard support plate.

6.2.8.4 Shaft centerlines of pumps shall be sufficient height above the baseplate to permit the piping of all auxiliary connections.

6.2.8.5 Pumps and drive units shall be aligned and mounted on the baseplate in the vendor's shop.

6.2.8.6 Grout holes in the engine baseplate shall be arranged so that the baseplate, with engine auxiliaries mounted in place, can be grouted without removing any components or piping. Adequate vent holes shall be provided to insure a complete distribution of grout.

6.2.9 Accessories

The pump manufacturer shall be prepared to supply the following:

a) Automatic air-release valve (self-venting pumps excluded).

b) Circulation relief valve (except for engine driven pumps for which engine cooling water is taken from the pump discharge).

c) Hose valve manifold with hose valves or equivalent water flow measuring device (outside type).

d) Pressure gages and recorder.

e) Relief valve and discharge cone (if required).

f) Splash shield between pump and motor (if required).

g) Ball drip.

h) Flow meter.

6.2.10 Material

6.2.10.1 Casting shall be smooth and free from scale, lumps, cracks, blisters, sand holes, and defects of any nature that may affect the use for which it is intended. Casting shall not be plugged or filled, but may be impregnated to remove porosity.

6.2.10.2 Unless otherwise specified casings shall be manufactured to either ASTM A 395 or equivalent nodular cast Iron.

6.2.10.3 Shafts shall be stainless steel alloy (AISI Type 416 or the equivalent) or of steel with corrosion-resistant shaft sleeves at stuffing boxes and passages through pump casings.

6.3 Vertical Turbine Pumps

6.3.1 Pump heads

The discharge head shall support the driver, the pump column, and the oil-tube tension nut or packing container. A separate combination pump-mounting plate and drive-support stand shall be furnished with the underground type.

6.3.2 Pump columns

The column for a pump shall be (1) furnished in sections not exceeding a nominal length of 10 feet (3.05 m), (2) of steel pipe complying with Table 6.3 or other pipe having equivalent strength and durability, and (3) connected by threaded-sleeve type couplings or flanges. The ends of each section of threaded pipe shall be faced parallel and machined with

threads to permit the ends to butt so as to form accurate alignment of the pump column. All column flange faces shall be parallel and machined for a rabbet fit to permit accurate alignment.

TABLE 6.3 PUMP COLUMN PIPE WEIGHT

NOMINAL DIAMETER	OUTSIDE DIAMETER, (mm)	WEIGHT (PLAIN ENDS) (kg/m)
150	168.28	28.22
200	219.08	36.74
225	244.48	42.14
250	273.05	46.41
300	323.85	65.11
350	355.60	81.17

6.3.3 Suction vessel

The suction vessel shall have structural strength and rigidity acceptable for the application. The wall thickness shall not be less than that of (1) Schedule 40 steel pipe or the equivalent if less than DN 200 in diameter and (2) Schedule 30 steel pipe or the equivalent if DN 200 or more in diameter.

6.3.4 Bowl assemblies

A pump bowl shall be provided with corrosion-resistant wearing rings that are made of material that will not gall. The rings shall be secured to the bowl in a manner that will not permit rotational or axial movement.

6.3.5 Impellers

Impellers shall be (1) made of corrosion-resistant material and (2) of the closed type. Impellers shall be securely fastened to the impeller shaft.

6.3.6 Impeller shafts

The impeller shafts shall be monel metal, stainless steel alloy (AISI Type 416 or the equivalent), or material having equivalent strength, rigidity, and resistance to corrosion.

6.3.7 Line shafts

The line shaft of a water-lubricated type pump (open line shaft) shall be stainless steel alloy (AISI Type 416 or the equivalent) or of steel with corrosion-resistant shaft sleeves at bearings and at stuffing boxes.

The line shaft of an oil-lubricated type pump (enclosed-line shaft) shall be of steel or material having equivalent strength and rigidity.

6.3.8 Line-shaft couplings

The line-shaft sections shall be connected by threaded couplings made of materials similar to those of the line shafts with which they are to be used. The threads shall be of the nontapered type.

6.3.9 Line-shaft bearings

Water-lubricated line-shaft bearings shall consist of rubber sleeves housed in corrosion-resistant metal spiders. The spider legs shall be streamlined to offer least resistance to the flow of water through the columns.

Oil-lubricated line-shaft bearings, for the enclosed-line shaft, shall be of corrosion-resistant material.

6.3.10 Shaft-enclosing tubing

For a pump of the enclosed-line, shaft oil-lubricated type, the shaft-enclosing tube shall be furnished in interchangeable sections of Schedule 80 (ANSI B36.10) or heavier pipe not more than 3.05 m long.

6.3.11 Oil lubricating means for enclosed shafts

For oil-lubricated type pump, an automatic sight-feed oiler and electrically operated valve energized from the driver circuit shall be provided on a mounting bracket with connection to the shaft tube.

6.3.12 Suction strainers

The suction manifold of a pump shall be provided with a cast or fabricated, corrosion-resistant, cone- or basket-type suction strainer. The strainer shall have a free area equal to at least four times the minimum cross-sectional area of the inlet opening to the first stage of the pump. The openings of the strainer shall not permit the passage of a (1) 7.9-mm or larger sphere for a pump rated 1892 L/min or less or (2) 12.7-mm or larger sphere for a pump rated more than 1892 L/min .

6.4 Name Plates

6.4.1 A corrosion resistant metal nameplate shall be permanently attached to the pump (not on baseplate) and contain the following information using specified units:

Equipment item number
Manufacturer's name
Serial number of pump
Size and type of pump
Rated capacity, M^3 / hr.
Differential pressure, kpa
RPM
Maximum allowable casing working pressure at maximum pumping temperature, kpa (G)
Working temperature range, °C

6.4.2 Each engine, turbine and/ or gear shall include purchaser's equipment item number on the vendor's standard name plate. Cast in or permanently attached direction of rotation arrow(s) shall be located on equipment housings at drive shaft extensions.

7. PERFORMANCE

7.1 Pumps shall have a rated capacity as specified in paragraphs 6.1.2 and shall have rated net pressure of 276 kpa(40 psig) or higher. More than one capacity-pressure rating may be developed for any pump. For each rated capacity, a pump shall develop not less than the rated total head.

7.2 Pump shall develop not less than 65 percent of rated total head when discharging at 1-1/2 times rated capacity.

7.3 The maximum net pressure for a vertical turbine, end-suction, or in-line pump shall not exceed 140 percent of rated head.

7.4 The maximum net pressure for a horizontal split-case pump shall not exceed 120 percent of rated head.

8. DRIVERS

Drivers shall be electric motors, diesel engines and / or steam turbines.

8.1 Electric Motors

8.1.1 All electric motors and related equipment and accessories shall be in accordance with IPS-M-EL-132, and shall comply with requirements of NFPA No. 20,1990 Edition.

8.1.2 Main and standby electric pumps shall be equipped for automatic starting.

8.1.3 The maximum speed of motors shall be 2900 RPM.

8.2 Diesel Engines

8.2.1 All diesel engines and related controls and equipments shall be in accordance with IPS-M-PM-280 and shall comply with the requirements of NFPA No. 20, 1989 Edition.

8.2.2 Diesel engine Kw (hp) rating shall be corrected for the site condition.

8.2.3 The maximum speed of diesel engines shall be 2300 RPM.

8.3 Steam Turbines

8.3.1 All steam turbines and related equipments shall be in accordance with IPS- M-PM-240 and shall comply with the requirements of NFPA No. 20, 1990 Edition.

8.3.2 Automatic control valve, when required, will be furnished by vendor.

9. INSPECTION AND TESTING

9.1 Inspection

9.1.1 Purchaser reserves the right to shop inspect purchased equipment. Purchaser's inspectors shall have entry to the portions of Manufacturer plants where work or testing on the purchased equipment is being performed. Manufacturer shall arrange for his subcontractors to also comply with these requirements, and shall furnish purchaser with pertinent information on subcontractors, schedules, and the equipment components involved when requested.

9.1.2 Manufacturer shall notify purchaser not less than 15 days prior to the date equipment will be ready for inspection or test.

9.1.3 Approval or release of equipment for shipment shall not relieve Manufacturer of any responsibility or guarantee. Acceptance of shop test, shall not constitute a waiver of field performance requirements under specified operating conditions, nor shall shop inspection by purchaser relieve Manufacturer of responsibilities in case of later discovery of defective material or workmanship.

9.1.4 The following information shall be given to the inspector upon request for the purchase order.

a) Evidence such as purchase specification or bills of materials to establish that major parts are of specified materials.

b) Copies of Manufacturer's unpriced purchase order to all subsuppliers.

c) Copies of shop test data for the purchased pump.

9.1.5 Purchaser's representative shall have the right to reject any part of equipment which does not conform to purchase order.

9.2 Testing

9.2.1 Operation test

9.2.1.1 The pump is to be subjected to an operation test at rated speed. Performance curves are to be plotted showing the efficiency, brake-horsepower (kW), and total head developed at shutoff, at rated capacity, at 150 percent of rated capacity, and at selected intermediate capacities between shutoff and maximum capacities exceeding 150 percent of rated capacity.

9.2.1.2 A pump intended for a range of rated net pressures is to be tested with impellers of different diameters to produce the minimum, intermediate, and maximum net pressures.

9.2.1.3 In lieu of the rated speed, the operation test may be conducted at a speed within ±10 percent of the rated speed, and the performance curves for the exact rated speed determined by means of the affinity relationships.

9.2.1.4 A test is to be conducted with a positive suction pressure sufficient to achieve the maximum brake-horsepower(kW output) required by the pump. This will be characterized by a leveling or gradual decline in the brake-horsepower (kW output) curve when plotted against increasing flow.

9.2.1.5 A horizontal split case, end suction, vertical turbine, or in-line pump provided with a suction vessel is to be tested at 150 percent of rated capacity with a net positive suction head (NPSH) at the pump suction flange of 5.79 m absolute (minus 4.57m) at sea level as determined by a mercury manometer installed at the inlet flange. During the test, the manometer is not to read less than 4.57 m of water vacuum when corrected to sea level and water temperature not exceeding 26.7°C.

9.2.3 Hydrostatic test

Each pump shall be Hydrostatically tested for a period of not less than four hours. The test pressure shall be not less than 1½ times the maximum allowable pressure of the pump, but in no case less than 17 bars. The water used for the test shall contain a suitable wetting agent.

9.2.4 NPSH test

An NPSH test shall be carried out if the available NPSH as indicated on data sheets does not exceed the required NPSH at all points between the minimum continuous flow and 15 % of rated flow by at least 0.5 meter. In this case, NPSHR data shall be taken at the following four points; minimum continuous flow, 75 % of rated flow, rated flow and 150 % of rated flow the NPSH test shall be in accordance with the test code of the Standards of the Hydraulic Institute.

9.2.5 Test certificates

Certified test reports for all tests carried out on pumps and drivers as well as certified performance curves shall be submitted to purchaser.

10. PREPARATION FOR SHIPMENT

10.1 "Preparation for Shipment" shall be in accordance with Manufacturer's standards and as noted herein. The manufacturer shall be solely responsible for the adequacy of the "Preparation for Shipment" provisions employed with respect to materials and application and to provide equipment to their destination in "ex-works" condition when handled by commercial carriers.

10.2 Pumps, drivers, and all furnished auxiliaries shall be shipped fully assembled on the baseplates, except as noted below. Coupling spacers with bolts and other items, such as minimum flow orifices which are not part of the pumping unit assembly, shall be separately boxed and securely attached to the baseplate.

10.3 Bearings, bearing housings , and oil system shall be thoroughly cleaned and coated with a suitable rust preventative. Surfaces contacted by the pumpage or working fluid, including stuffing boxes and flush piping, shall be thoroughly dried. Surfaces which are subject to atmospheric corrosion or rusting shall be coated with a suitable rust preventative. Mechanical seal assemblies shall be fully protected from rusting and entry of moisture and dirt.

External nonpainted surfaces (except stainless steel) including bolting and flange faces, shall be coated with a suitable rust preventative.

10.4 External surfaces of pumps, drivers, baseplates, accessories, and piping, except stainless steel and finished surfaces shall be painted prior to being shipped from the Manufacturer's shop. Manufacturer's standard cleaning and painting procedures for the operating temperatures of equipment are acceptable.

10.5 Exposed shafts and shaft couplings shall be wrapped with waterproof moldable waxed cloth or barrier type VPI paper. The seams shall be sealed with adhesive tape.

10.6 All threaded openings shall be plugged with long shank pipe plugs. Plug material shall be equivalent to the material being plugged, except that carbon steel plugs shall be used with openings in cast iron.

10.7 Flanged openings shall be provided with full flange diameter protective covers in accordance with a or b below:

a) Cover material shall be 5 mm (minimum) thick metal plate. A full diameter gasket shall be supplied between the flange and the metal cover-plate.

The metal cover-plate shall be held to the flange by a minimum of four full diameter bolts and nuts.

b) Cover material shall be 6 mm (minimum) thick, low density 'Poly-Foam" polyethylene plastic flange guards. Flange guards shall be held in place by "Poly-Bolt" plastic lock plugs in every other bolt hole (minimum four plugs).

10.8 Each item shall be identified with its Purchase Order Number and Item Number. Tags shall be corrosion resistant metal (not aluminum) and impression stamped.

10.9 Tags shall be attached to each component with stainless steel wire. This tagging is in addition to the equipment nameplate. Equipment shipped in fully enclosed containers shall also include the above information marked on the outside of the container.

10.10 Miscellaneous parts shall be tagged or marked with the equipment item number for which they are intended.

10.11 One complete set of the installation, operation and maintenance instructions in addition to the number called for in the purchase order shall be packed in the boxes or crates with the equipment.

11. VENDOR'S DATA

11.1 Proposal

11.1.1 An individual price and delivery schedule must be quoted for each equipment item number.

11.1.2 The following information is required with each proposal:

- Preliminary outline dimension drawing for pump, driver and speed changer.

- Typical cross sectional drawing for pump, driver and speed changer.

- Pump performance curves which include differential head, efficiency, water NPSHR, and brake kW (hp) all expressed as functions of capacity.

- These curves shall be extended to at least 125 percent of capacity at peak efficiency.

- Pump head-capacity curve for maximum diameter impeller(s).

- Steam turbine performance curves based on normal operating conditions.

- Details of proposed pressure lubrication systems, including lube oil schematic when required.

- Completed related data sheets.

- Two years & start up priced list of recommended spares .

11.2 Drawing and Data

11.2.1 The data shall be identified on transmittal (cover) letters and in title blocks or pages with the following information:

a) The purchaser/ user's corporate name.

b) The job/project number.

c) The equipment name and item number.

d) The purchase order number.

e) Any other identification specified in the purchase order.

f) The vendor's identifying shop order number, serial number, or other reference required to identify return correspondence completely.

11.2.2 The vendor shall indicate in the drawings or in cross-reference lists the equipment item numbers of various components, connection points and locations, instrumentation, and other data as required by the purchaser.

11.2.3 The drawings furnished shall contain sufficient information, when combined with the manuals to enable the purchaser to properly install, operate and maintain the ordered equipment.

11.2.4 Certified correct dimensional drawings of completely assembled units shall be supplied. These drawing shall show:

- Identification data for pump, coupling and driver.

- Rotation.

- Weight.

- Adequate dimensional data to permit the design of foundation, piping and wiring connections.

- Location of motor junction box(es)

- Piping connection identified, with the size, rating, and facing indicated.

- Clearance required for disassembly and maintenance.

- Completed related data sheets.

11.2.5 Auxiliary connections listed on the composite outline drawing shall be identified as follows:

- Not furnished this order.

- Plugged, requires field piping by purchaser.

- Piped by manufacturer.

11.2.6 The composite outline drawing shall also reference any supplementary drawings required to complete the pump auxiliary piping-Seal flushing and cooling water piping.

11.2.7 A cross sectional drawing shall be supplied (without dimensions) which identifies parts and a listing of the parts which agrees with the equipment furnished.

11.2.8 Bills of Material for pump and driver must include:

- Part number.

- Name of parts.

- Number of parts required.

- Metallurgy of part (identified by ASTM number or similar).

- Drawing number which identifies each part as to interchangeability.

11.2.9 A general arrangement and layout of auxiliary piping shall be supplied to show its approximate location and routing relating to the major components. A material list must be shown on the drawing. The auxiliary piping system shall include and identify all components by make, type, size, capacity, pressure rating , materials and the like, as applicable.

11.2.10 Drawings shall show the seal in cross section with parts numbered and identified. Installation and setting dimensions shall be shown. A bill of material must be included on the drawings. Stuffing box shall be fully dimensioned.

11.2.11 Vendor shall describe installation, operating and maintenance procedures for all equipment, auxiliaries and instruments furnished by the Manufacturer and any subsuppliers.

11.2.12 Lubrication schedule which shall include all equipment furnished by the Manufacturer shall be furnished including:

- Recommended lubricant for use during break-in and normal operation, to meet Purchaser requirements.
- Method of application of the lubricant.
- Quantity of initial fill.
- Quantity of lubricant shipped with initial order.
- Recommended break-in period of initial application.
- Recommended time between change of lubrication.
- Refill quantities and quality if different from initial change.
- Technical specification of each lubricant to be used including ISO number, etc.
- Expected annual consumption.
- Note any special lubrication precaution, or detailed lubrication consideration to be observed on the equipment.

11.2.13 Vendor drawings shall include parts lists for all equipment furnished by the manufacturer and subsupplier and shall show pattern stock or production drawing numbers, materials of construction and quantities of items required per pump.

Standard purchased items shall be identified by the original Manufacturer's numbers.

12. GUARANTEE AND WARRANTY

12.1 Mechanical

Unless exception is recorded by the vendor in his proposal, it shall be understood mutually that the vendor agrees to the following: During a period of 12 months after the date of commissioning, the vendor shall, with all possible speed and without cost to the purchaser, replace or repair the goods or any part there of found to be defective due to faulty material,workmanship or to any act or omission of the vendor. In the particular the vendor shall reimburse any transportation and other charges incurred by the purchaser in effecting such replacement or repair at the point of use.

12.2 Performance

The complete pumping assembly and all control equipment shall be guaranteed in writing for pressure, capacity and power consumption as required by NFPA No. 20, latest edition.

APPENDICES

APPENDIX A
DATA SHEETS FOR FIRE WATER PUMP

SHEET No. 1 REV. _____
DATE. _____ BY _____
JOB No. _____ CHK'D. _____
P.O.No. _____

Note:

c INDICATES INFORMATION TO BE COMPLETED BY PURCHASER:

b BY VINDOR APPLICABLE TO : PROPOSALS c PURCHASE c AS BUILT c

CLINET _____ ITEM No. _____ No. PUMPS REQD _____
UNIT _____ DRIVER. MOTOR _____ FURNISHED BY _____
PUMP MFR. _____ TURBINE _____ FURNISHED BY _____
SIZE AND MODEL _____ ENGINE _____ FURNISHED BY _____

GENERAL

APPLICABLE SPECS: ○ NFPA 20 ○ UL ○ OTHER _____
LABEL REQUIRED: ○ YES ○ NO
ENVIRONMENT: ○ INDOORS ○ OUT DOORS ELEV. _____
AMBIENT TEMP MIN _____ MAX _____ WET BULB C _____
PROTECTION REQD. ○ WINTERIZATION ○ TROPICALIZATION ○ OTHER _____
PUMP: ○ HORIZ. ○ VERT GEAR: ○ YES ○NO

OPERATING CONDITIONS

LIQUID _____ $M^3/HR.$ _____
TEMP °C _____ DISCH. PRES. KPa G. _____
SP. GR _____ SUCT. PRES. KPa G. _____
VAP PRES. KPa A _____ DIFF. PRES. KPa _____
NPSHA M. _____ HYD KW (HP) _____

PUMP PERFORMANCE

☐ PROPOSAL CURVE No. _____
☐ RPM _____ ☐ EFF. _____ ☐ NPSHR. M _____
☐ MAXDIFF. PRES. KPa. _____ ☐ RATED B KW _____
☐ SUBMERGENCE REQD. M. _____ ☐ MAX. B KW _____

RIGHT ANGLE GEAR

☐ KW. RATED _____ ○ ITEM No. _____
☐ KW. MAX _____ ☐ SERVICE FACTOR _____
☐ RPM IN _____ ☐ PRM OUT _____ ☐ RADO _____
☐ VERT. THRUS CAP. kg _____ UP _____ ON ☐ EFF _____
☐ LUBRICATION _____
☐ MFR _____ ☐ MODEL & SIZE _____

STEAM TURBINE DRIVER

☐ KW. RATED _____ ☐ RPM _____ ○ ITEM No. _____
☐ MFR _____ ☐ MODEL & SIZE _____
STEAM: ○ INLET KPaG. _____ ○ NLET TEMP. °C _____
○ EXHAUST KPaG. _____ ☐ RATE. kg/KW/Hr _____

HORIZONTAL PUMP CONSTRUTION

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION				
DISCHARGE				

CASE-MOUNTS ☐ CENTERLINE ☐ FOOT ☐ BRACKET
-SPLIT ☐ AXIAL ☐ RADIAL
-PRES ☐ MAX ALLOWED _____ ☐ HYDROTEST _____
IMPELLER DIA ☐ RATED _____ ☐ MAX. _____
BEARINGS-TYPE ☐ RADIAL _____ ☐ THRUST _____
LUBE. ☐ RING OIL ☐ FLOOD
COUPLING: ☐ MFR _____ ☐ MODEI _____
PACKING: ☐ MFR & MTL _____
MECH SEAL ☐ MFR, MOD. & MTL _____

○ MATERIALS:	
☐ CASE	☐ SHAFT
☐ IMPELLER	☐ SLEEVE
☐ WEAR PARTS	☐ GLAND
☐	☐

VERTICAL PUMP CONSTRUCTION

○ SUMP DEPTH M. _____
DISCH NOZZLE. ○ ABOVE ○ BELOW SURFACE
☐ SIZE _____ ☐ RATING _____ ☐ FACING _____
COLUMN PIPE: ☐ FLANGED ☐ THREADED
LINE SHAFT: ☐ OPEN ☐ ENCLOSED
IMPELLER DIA: ☐ RATED _____ ☐ MAX. _____
COUPLING ☐ MFR _____ ☐ MODEL _____
PACKING: ☐ MFR & MTL _____
MECH. SEAL: ☐ MFR MOD. & MTL _____

○ MATERIALS	
☐ BOWL	☐ SHAFT
☐ IMPELLER	☐ SLEEVE
☐ SUCT. BELL	☐ GLAND
☐ COLUMN	☐ BOWL BRG.
☐ HEAD	☐ LINESHAFT BRG.
☐	☐

COMMENTS:

(to be continued)

APPENDIX A
DATA SHEETS FOR FIRE WATER PUMP

(continued)

SHEET No. 2 REV.

ELECTRIC DRIVER	ENGINE DRIVER
☐ KW ——— ☐ RPM ——— ○ ITEM No. ———	☐ KW RATED ——— ☐ RPM ——— ○ ITEM No. ———
☐ FRAME ——— ○ VOLTS / PH / HZ ———	☐ MFR ——— ☐ MODEL ——— ☐ DISPL ———
☐ BEARINGS - TYPE ——— ☐ LUBE ——— ☐ MFR ———	☐ No. OF CYLINDERS ———
○ TYPE ——— ○ ENCL ——— ○ INSUL ———	TURBOCHARGED ☐ YES ☐ NO ☐ MAX RPM ———
☐ F.L. AMPS ——— ☐ L.p. AMPS ——— ☐ C RISE ———	GOVERNOR ○ VARIABLE: ——— %. (-) ——— % ○ CONSTANT
○ VHS ○ VSS ☐ VERT. THRUST CAP. kg ——— UP ——— ON	○ HYD ○ MECH. ○ NEMA CLASS ———
	☐ MFR ——— ☐ MODEL ———
ELECTRIC DRIVE CONTROL PANEL	START: ○ ELECTRIC ○ AIR ○ GAS
☐ MFR: ——— ☐ MODEL No. ———	SHUTDOWN. ○ FULE VENTED ○ INLET AIR
○ AUTOMATIC ○ NON. AUTOMATIC ○ LTD. SERVICE	☐ GUARANTEED FUEL RATE ○ RATED LOAD
○ REMOTE START ○ SEQUENTIAL - STARTING	○ FUEL SYSTEM ———
○ DELUGE SYSTEM ○ CONTINUOUS RUN OPERATION	
○ DRY SYSTEM ○ POWER FAILURE INDICTOR	
○ MINTIME RUN RELAY	COOLING: ○ COOLING WATER SOLENOID VALVE
STARTING ○ ACROSS THE LINE ○ REDUCED VOLTAGE	☐ HEAT REJECTION, K cal / BKW - HR
○ CIRCUIT BREAKER INTERRUPTING CAPACITY ———	○ THERMOSTATICALTY CONTROLLED HEATER
○ CIRCUIT BREAKER INTERRUPTING CURRENT ———	TO MAINTAIN ENGINE TEMP BETWEEN,
TEST CONNECTIONS ○ TERMINALS ○ TEST LINK	——— °C AND ——— °C WITH AMBIENT
○ PUMP START ON LOSS OF ALARM CIRCUIT POWER	AIR TEMP OF ——— °C
○ TEST RECORDING GAGE	BATTERY ○ LEAD ACID ○ NICKEL CADMIUM
○ MANUAL SHUTDOWN ○ AUTOMATIC SHUTDOWN	○ EARTHQUAKE PROOF BATTERY RACK
PRESSURE SWITCH SETTINGS ○ HIGH ——— ○ LOW ———	
ALARMS AND SIGNALS (ON CONTROLLER)	AIR START ☐ ——— kg/cm^3 °C ——— STD M^3 / START
○ PILOT LAMP, AC. POWER AVAILABILITY	
○ ———	○ AIR INLET FILTER ○ DRY ○ OIL BATH
ALARMS AND SIGNALS (REMOTE):	
○ ———	EXHAUST SILENCER ○ RESIDENTIAL ○ INDUSTRIAL
○ ———	

ENGINE DRIVE CONTROL PANEL	
☐ MFR: ——— ☐ MODEL No. ———	ALARMS AND SIGNALS (ON CONTROLLER)
○ AUTOMATIC ○ NON. AUTOMATIC ○ REMOTE. MAN	○ PILOT LAMP A.C POWER AVAILABILITY
○ A.C. ELECTRICAL SERVICE AVAILABLE ———	○ PILOT LAMP. BATTERY CONDITION
○ ENCLOSURE HEATER REQUIRED	○ PILOT LAMP AND BELL, LOW OIL PRESSURE
○ PUMP START ON LOSS OF ALARM CIRCUIT POWER	○ PILOT LAMP AND BELL, HIGH ENGINE TEMP.
○ DELUGE SYSTEM. ○ DRY SYSTEM	○ PILOT LAMP AND BELL. ENGINE STARTING FAILURE
○ SEQUENTIAL STARTING ○ POWER FAILURE START	○ ———
○ WEEKLY TEST TIMER ○ TEST RECORDING GAGE	○ ———
○ MANUAL SHUTDOWN ○ AUTOMATIC SHUTDOWN	ALARMS AND SIGNALS (REMOTE).
○ POWER SPEED SHUTDOWN ○ COOLING WATER SOLENOID	○ ———
PRESSURE SWITCH SETTINGS: ○ HIGH ——— ○ LOW ———	○ ———

COMMENTS.

APPENDIX B
PIPE COMPONENTS NOMINAL SIZE

The purpose of this appendix is to establish an equivalent identity for the piping components nominal sizes in Imperial system and SI unit.

TABLE B1

NOMINAL SIZE		NOMINAL SIZE		NOMINAL SIZE		NOMINAL SIZE	
DN (1)	NPS(2)	DN	NPS	DN	NPS	DN	NPS
15	½	100	4	500	20	1000	40
20	¾	125	5	600	24	1050	42
25	1	150	6	650	26	1100	44
32	1¼	200	8	700	28	1150	40
40	1½	250	10	750	30	1200	48
50	2	300	12	800	32	1300	52
65	2½	350	14	850	34	1400	56
80	3	400	16	900	36	1500	60
90	3½	450	18	950	38	1800	72

1) **Diameter nominal, mm**

2) **Nominal pipe size, inch**

APPENDIX C
PIPE FLANGES PRESSURE TEMPERATURE RATING

The purpose of this appendix is to establish an equivalent identity for the pipe flange nominal pressure temperature ratings in Imperial system and SI unit

TABLE C1

PN (1)	ANSI RATING CLASS
20	150
50	300
68	400
100	600
250	1500
420	2500

1) Pressure Nominal, bar