

WATER SUPPLIES DEPARTMENT

STANDARD SPECIFICATION M-01-01

CENTRIFUGAL PUMPS

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CENTRIFUGAL PUMPS

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WATER SUPPLIES DEPARTMENT
STANDARD SPECIFICATION M-01-01
CENTRIFUGAL PUMPS

1. DESIGN

The pump shall be of centrifugal type and of robust construction with all rotating parts carefully balanced to prevent undue vibration. The pump shall have high efficiencies at the specified pump duty points.

Pumps with one or two stages shall have axially split casings with the suction and delivery flanges cast into the fixed half to allow full accessibility to all internal parts without disturbing the alignment of the pumpset or breaking the pipe joints. The design of coupling shall allow the pump to be removed without disturbing the motor.

The pump shall be designed so that no thrust is transmitted to the driving motor and multistage pumps are to be provided with a balance disc/device to reduce the thrust on the pump bearings.

The pumpset vibration level shall be within the limits specified under Zone B of ISO 20816-3 for the motor and Zone B of ISO 10816-7 Category II for the pump.

For pumpsets equipped with driving motor rating equal to 40kW or above, the maximum permissible pumpset speed shall not exceed 1500 rpm.

The pump shall be free from unacceptable noise. The limiting sound pressure level of the pumpset with the motor coupled up at the pump closed valve head shall not exceed 94 dBA measured to BS EN ISO 1680 at any point 1 m from the pumpset.

All rotating parts, including the intermediate shafting, shall be provided with fixed perforated guards in accordance with the Factories and Industrial Undertakings (Guarding and Operation of Machinery) Regulations. Hinged covers shall be provided at suitable locations of the safety guards to facilitate future maintenance.

2. DUTIES AND CHARACTERISTICS

The pump shall have a stable characteristic and be capable of continuous operation at the specified range of flow rate. The closed valve head of the pump shall be not less than 120% of the pumping head at its duty points.

For calculating the available net positive suction head (NPSH) at the

pump for any operating condition, the minimum atmospheric pressure shall be taken as 10 m of water and the maximum vapour pressure of water as 0.3 m of water. The curve of NPSH required by the pump shall be submitted for assessment.

3. **HORIZONTAL PUMPSETS**

Unless otherwise specified, the pumpset supplied shall be complete with pump, driving motor, coupling, and foundation bolts and bedplate. The pump shall be mounted on a common bedplate with the motor.

The bedplate shall be of a robust and rigid design to ensure that there is no vibration of the plant, and designed so as to allow suitable cable access to the motor cable box.

4. **VERTICAL PUMPSETS**

Unless otherwise specified, the pumpset supplied shall be complete with pump, driving motor, coupling, foundation bolts and soleplate.

When the motor is coupled to the pump by an extension shaft, the motor shall be mounted on a stool and a soleplate suitable for mounting on the floor. Unless otherwise specified, an adjustable extension shaft complete with universal joints and couplings for power transmission shall be supplied. Each pumpset shall be supplied with an appropriate fixture for supporting and securing the extension shaft when the motor is decoupled for maintenance. Where specified in the Particular Specification, an intermediate bearing shall be supplied. Plummer block bearing housing or flanged bearing housing of grease lubricating type shall be fitted with a grease nipple for relubrication.

When the motor is coupled directly to the pump, the pump motor shall be supported on its own steel stand and soleplate over the pump. The motor stand shall be so designed that full access to the pump is maintained to facilitate maintenance, and suitable working platform for access to the top of the motor shall be provided. The motor stand shall be free from undue vibration when the motor / pumpset is operating.

Foundation bolts shall be supplied for the motor stool, stand, soleplate and for the pump. Means must be provided to enable the pump rotating element to be withdrawn without difficulty, and without disturbing the motor. A water thrower shall be provided to protect the lower bearing except the water lubricated type.

5. **MATERIALS OF CONSTRUCTION**

The pump shall be manufactured from the following materials or from materials superior to the following:

Item	Raw, Fresh and Recycled Water	Salt Water
Casing	Grey Cast Iron BS EN 1561, Designation EN-GJL-250 or GB/T 9439, Designation HT250	Duplex Stainless Steel ASTM A995 CD4MCuN
Pump Bearing House	Grey Cast Iron BS EN 1561, Designation EN-GJL-250 or GB/T 9439, Designation HT250	Grey Cast Iron BS EN 1561, Designation EN-GJL-250 or GB/T 9439, Designation HT250 Duplex Stainless Steel (Compatible Grade) (for vertical pump lower bearing house)
Casing Wear Rings (Neck Rings)	Lead-free Copper Alloy suitable for potable water application BS EN 1982 or equivalent GB/T standards or Stainless Steel BS EN 10088 or GB/T 20878 (Compatible Grade)	Duplex Stainless Steel (Compatible Grade)
Impeller	Stainless Steel BS EN 10283, Designation 1.4408 or GB/T 2100, Designation ZG07Cr19Ni11Mo2	Duplex Stainless Steel ASTM A995 CD4MCuN
Impeller Wear Rings (Eye Rings)	Lead-free Copper Alloy suitable for potable water application BS EN 1982 or equivalent GB/T standards or Stainless Steel BS EN 10088 or GB/T 20878 (Compatible Grade)	Duplex Stainless Steel (Compatible Grade)

Item	Raw, Fresh and Recycled Water	Salt Water
Pump Shaft and Keys for Securing Impeller	Stainless Steel BS EN 10088-3, Designation 1.4057 or GB/T 20878, Designation S43120	Duplex Stainless Steel ASTM A276 S32760
Keys for Securing Half Coupling	Carbon Steel BS EN ISO 683, Designation C45 or GB/T 699, Designation 45	Duplex Stainless Steel ASTM A276 S32760
Shaft Sleeves	Stainless Steel BS EN 10088, Designation 1.4401 or GB/T 20878, Designation S31608 or Same as that for Impeller (depends on the manufacturing process adopted)	Duplex Stainless Steel (Compatible Grade)
Bolts, Nuts, Studs, Dowels, Washers, Jacket cover etc.	---	Suitable grades of Stainless Steel

6. PUMP CASING

6.1 Design

The pump casing shall be fitted with renewable wear rings (neck rings). The suction and delivery flanges of the pump casing shall be faced and drilled to BS EN 1092 and positioned as detailed in the Particular Specification.

Bosses, radially drilled and tapped to receive the pressure gauge connections, shall be provided on the suction and delivery sides adjacent to the flanges. Means shall be provided to drain the casing and an air release cock of adequate size shall be fitted at the uppermost point on each stage.

Except for salt water pumps, coating for internal wetted surface shall be suitable for potable water application and in compliance with BS 6920 or equivalent.

Painting and final colours of the pump casings shall comply with the requirements stipulated in Water Supplies Department Standard Specification EM-00-03. Surface painting is not required on the duplex stainless steel pump casings.

6.2 Ceramic Composite Coating (Optional Item)

If so specified in the Particular Specification that an advanced ceramic composite coating shall be applied to the interior surface of the pump casing for pump efficiency enhancement and protection against erosion and corrosion, the Contractor shall submit technical details of the coating offered to the Engineer of Contract for approval / *NEC Project Manager* for acceptance, prior to its application.

The composition of the coating shall be epoxy matrix blended with ceramic reinforcements, which shall be able to provide high gloss surface finish and good erosion and corrosion resistance. If the pump is for fresh or raw water application, the coating offered shall be suitable for potable water application and in compliance with BS 6920 or equivalent.

Prior to application of the coating, the pump casing surfaces shall be thoroughly cleaned, degreased and sand blasted to the coating manufacturer's requirements. The method of application, such as control of ambient temperature, humidity, curing time, dry film thickness of each coat etc. as prescribed by the coating manufacturer shall be strictly followed.

The coating shall be visually inspected by the Independent Inspection Body (IIB)'s representative for craters, pinholes and pores prior to the test. In addition to those tests recommended by the coating manufacturer, Holiday test and dry film thickness measurements shall also be conducted by the pump manufacturer in the presence of the IIB representative to ensure quality of the coating applied. Any defects on the coating shall be properly repaired by the pump manufacturer in accordance with the coating manufacturer's recommendations.

7. PUMP IMPELLER AND SHAFT

The pump impeller and shaft with its coupling(s) shall be dynamically balanced by the manufacturer in their shop in accordance with ISO 21940-11 of quality grade G6.3 or better, or in accordance with other equivalent international standards.

The impeller shall be designed with sufficient strength at the boss to withstand all possible stresses imposed by the drive. The impeller shall be machined to close limits and properly finished. It shall be fitted with wear rings or allowed with sufficient materials and strength at the wearing surface of the impeller eye for future machining and/or fitting the impeller wear rings during the service life of the impeller.

The sections of pump shaft which are susceptible to wear shall be protected by replaceable sleeves.

8. **MECHANICAL SEALS**

The pump shall be fitted with mechanical seals suitable for use with a pressure of at least the closed valve head of the pump plus the maximum static suction head.

All metallic parts of mechanical seals of salt water pumps shall be of Grade 316 stainless steel. The mechanical seal flushing water shall be taken from the pump casing and the flushing system shall be fitted with cyclone separators, sight flow indicators, flow switches and isolating valves to protect the seals from damage caused by suspended debris in the water. The sight flow indicator shall be equipped with a manual internal wiper operated externally for cleaning of the flow indicator. An additional tee connection with an isolating valve for connecting to an alternative flushing water supply shall be provided.

9. **BEARINGS**

Ball and roller type bearings shall be sealed, grease lubricated and protected from the ingress of dust and water. These bearings shall conform to ISO 281, GB/T 6391 or other equivalent standards and shall be readily obtainable in the market. Special bearings and imperial size bearings are not acceptable. The temperature settings for alarm and tripping initiation shall not be higher than 75°C and 80°C respectively. If the pump manufacturer recommends higher temperature settings, technical details together with the justifications shall be submitted to the Engineer for approval/ acceptance by NEC *Project Manager*.

Oil lubricated plain bearings may be used where necessary. Each bearing shall be fitted with an oil level sight glass.

For pumpset of 70kW and above, each pump bearing shall be provided with a resistance temperature detector (RTD) and a monitoring unit for temperature indication and contacts for two-level separate alarm and tripping initiation. The monitoring units shall be installed in the pumpset instrument panel.

For vertical pumpset, the lower bearing can be of water-lubricated rubber type journal bearing. Such bearing shall be properly designed and supplied with a pressurised flushing water system tapped from the casing of the pump and complete with all necessary ancillary equipment including cyclone separator, strainer, sight flow indicator, isolating valves and protection flow switch. The sight flow indicator shall be equipped with a manual internal wiper operated externally for cleaning of the flow indicator.

10. **GAUGES**

Bourdon tube suction and delivery pressure gauges of suitable range and graduated in both kPa and metres head of water shall be provided.

The pressure gauges shall be in compliance with Water Supplies Department (WSD) Standard Specification EM-01-03.

The gauges complete with isolating cocks shall be mounted at the branches to which they apply. Static head correction is not required.

An additional tee connection, with a separate isolating cock shall be provided between the gauge and pump branch for connecting to portable instruments.

11. **SMALL BORE PIPEWORK**

The small bore pipework, isolating valves, fittings and ancillary equipment including cyclone separator, strainer, sight flow indicator, isolating valves and protection flow switch for the flushing and cooling systems and pipe connections for instrumentation including isolating cocks and boss plugs shall be of Grade 316 stainless steel.

12. **PUMP TESTS**

12.1 **Work Tests**

All works tests shall be carried out in the presence of representatives of an IIB approved by the Engineer / accepted by the NEC *Project Manager*.

The pump casing shall be hydraulically tested to 1.5 times the maximum attainable pressure in the system, or to a value as specified in the Particular Specification, which shall take into account the maximum suction head, closed valve head and the effects of system surge. During the hydraulic test, the test pressure shall be sustained for a period of not less than 10 minutes.

The pump shall then be coupled to its own driving motor to be supplied and tested at the pump manufacturer’s works to BS EN ISO 9906 to the acceptance grade according to the table below over the full range of its capabilities to determine pump output, power absorbed, efficiency and the required NPSH:

	Shaft Input Power of the Pump	
	> 10 kW and ≤ 100 kW	> 100 kW
Acceptance Grade	2B	1B

No lubricants shall be applied to the impeller and internal surface of the pump casing prior to the test.

On completion of all tests, the pump shall be cleaned thoroughly with clean water and the motor shall be refitted with the rotor locking device before packing for shipment.

12.2 Site Tests

The pumpset supplied shall be subject to site tests to evaluate its performance under site conditions over the full operating range. The tests shall be conducted in accordance with BS EN ISO 9906 to the acceptance grade 2B as far as practically possible.

The Contractor shall carry out the site tests in accordance with the site test forms attached in the Appendix. For proposed changes to the site test forms or other site tests which are not included in the Appendix, the Contractor shall submit the test forms and procedures to the Engineer for approval / acceptance by *NEC Project Manager* prior to carrying out the tests.

Suitable boss openings with isolation valves & plugs shall be provided at the pump suction and discharge pipe for conducting performance test.

12.3 Pump Performance Test using Yatesmeter¹ (Optional Item)

If so specified in the Particular Specification that the pumpset supplied shall be tested at the manufacturer's works using Yatesmeter in addition to the conventional pump performance test as specified in Sub-clause 12.1 above, the Contractor shall collect the Yatesmeter from WSD and have it delivered to the manufacturer's works for the test. Upon completion of the test, the Yatesmeter shall be returned to the Employer / *NEC Client* as soon as possible. All necessary costs, including delivery of the Yatesmeter and the appointment of IIB for witnessing the test using Yatesmeter, shall be borne by the Contractor. In case the Yatesmeter is damaged or lost while under the possession of the Contractor, the Contractor shall either repair the Yatesmeter to the satisfaction of the Engineer or compensate the Engineer by providing a new Yatesmeter with the same or superior functionalities and measurement capabilities.

The result of the test is for reference only and will not be used for assessing whether the guaranteed Specific Power Consumption (SPC) and pump output, if these figures are stipulated in the Contract, have been achieved.

In addition, the site test as specified in Sub-clause 12.2 above shall be carried out by the Contractor using the same Yatesmeter in the presence of the Engineer's Representatives so as to ascertain the effect that actual site conditions may have on pump efficiency and pump output. Test reports with pump performance curves for comparing the site test results with those obtained at the manufacturer's works shall be provided by the Contractor.

¹ Yatesmeter is a pump performance test apparatus developed by Advanced Energy Monitoring System Inc. based on thermodynamic method.

13. INFORMATION TO BE PROVIDED IN THE PARTICULAR SPECIFICATION

The following information shall be provided in the Particular Specification in addition to this Standard Specification.

Clause in this Standard Specification	Requirement to be specified in the Particular Specification
Clause 1 Design	● To specify whether the pumpset shall be horizontally or vertically mounted.
Clause 4 Vertical Pumpsets	● To specify if extension shaft(s) and plummer block bearing(s) are necessary.
Clause 5 Materials of Construction	● Type of water to be handled by the pump.
Clause 6.2 Ceramic Composite Coating	● To specify if the pump casing is to be internally coated with ceramic composite coating.
Clause 12.3 Pump Performance Test using Yatesmeter	● To specify if additional pump performance test using Yatesmeter is required.

14. INFORMATION REQUIRED IN THE MATERIAL SUBMISSION BY THE CONTRACTOR

The following information shall be provided in the material submission for approval by the Engineer of Contract / acceptance by the NEC *Project Manager*.

Item	Description	Details
1	Technical Schedule	Manufacturer
		Country of origin
		Model / Type
		No. of stages of pump
		Flow capacity at duty point(s)
		Total head at duty point(s)
		Efficiency at duty point(s)
		NPSH required at duty point(s)
		Maximum NPSH required for full range of operation
		Minimum operating head and corresponding flow rate for continuous trouble-free operation
		Zero flow head

		Rated speed
		Rotation direction
		Materials and coatings
		Suction and discharge flange sizes and standard
		Maximum power absorbed over the whole operating range
		Weight of the complete pump, and the heaviest assembly to be lifted during overhaul
		Inertia of pump rotating parts including entrained water
		Maximum sound pressure level 1 m from pumpset at zero flow head
		Particulars for bearings
		Particulars for mechanical seals
2	Compliance with Standard Specification M-01-01	
3	Compliance with Particular Specification	
4	Pump Catalogue	Outline and sectional drawing of the pump and mechanical seal, indicating the general dimensions, flow and rotation direction, components, materials and quantities
		Schematic drawing of pump flushing and cooling system
		Pump performance curves, indicating the flow rate, total head, efficiency, NPSH required, shaft power and the duty point(s)
		Coating
5	Extension shaft (If applicable)	Manufacturer
		Country of origin
		Model / Type
		International standard
		Material of construction
		Details of universal joint and plummer block bearings, and bearing life estimation
		Shaft selection according to calculations of strength, torque, fatigue, and critical speed
		Sectional drawings of the shaft and the elevation of the entire pumpset
		Catalogue
6	Certificates	Certificate of origin
		Water Regulations Approval Scheme (WRAS) certificate

- End of Specification -

WSD M-01-01 Site Test Form 2
Performance Test of Pumpset

Contract no.: _____
 Contract title: _____
 Contractor: _____ Shaft Input Power: _____
 Location: _____ Pump Model: _____
 Pumpset no.: _____ Serial No.: _____
 Manufacturer: _____ Motor Model: _____
 Date: _____ Serial No.: _____

Starting current: _____ (A)
Suction
 Level of pressure gauge: (z1) _____ (m) above pipe centre
 Pipe diameter: _____ (m)
 Pipe internal area: _____ (m2)

Starting time: _____ (sec)
Discharge
 Level of pressure gauge: (z2) _____ (m) above pipe centre
 Pipe diameter: _____ (m)
 Pipe internal area: _____ (m2)

Time	Suction head (corrected to pipe centre) Ps		Discharge head (corrected to pipe centre) Pd		Velocity head	Total head H	Flow rate Q	Shaft power P	Pump efficiency	Current	Voltage	Motor input power W	Motor efficiency	Overall efficiency
	Valve opening %	(m)	Valve opening %	(m)	(m)	(m)	(m3/h)	(W)	(%)	(A)	(V)	(W)	(%)	(%)

WSD M-01-01 Site Test Form 2
Performance Test of Pumpset

Time	Speed	Results from Yatesmeter			
	(rpm)	Total head H (m)	Flow rate Q (m ³ /h)	Shaft power P (W)	Pump efficiency (%)

Pressure Test		
Maximum suction head		(m)
Zero flow head		(m)
150% of maximum operating pressure		(m)
No leakage for 10 minutes	Y/N	

Test Instrument	Manufacturer	Model	Serial No.	Calibration Certificate no.	Expiry Date
1					
2					
3					
4					

Remarks: _____

Tested by: _____ Date: _____
 (Signature) (Name in block letter)

Witnessed by: _____ Date: _____
 (Signature) (Name in block letter)

Witnessed by: _____ Date: _____
 (Signature) (Name in block letter)

WSD M-01-01 Site Test Form 4
Vibration Level of Pumpset

Contract no.: _____
 Contract title: _____
 Contractor: _____ Shaft Input Power: _____
 Location: _____ Pump Model: _____
 Pumpset no.: _____ Serial No.: _____
 Manufacturer: _____ Motor Model: _____
 Date: _____ Serial No.: _____

Remark:
 All measurements in mm/s (RMS) on bearing housing
 X direction - parallel to pump discharge pipe
 Y direction - perpendicular to pump discharge pipe

Measurement	No. 1			No. 2			No. 3		
	Flow:			Flow:			Flow:		
	Head:			Head:			Head:		
	Operating pumps:			Operating pumps:			Operating pumps:		
	X	Y	Axial	X	Y	Axial	X	Y	Axial
Motor NDE									
Motor DE									
Intermediate bearing no. 1									
Intermediate bearing no. 2									
Pump DE									
Pump NDE									

Acceptance criteria:
 Motor: Zone B of ISO 20816-3
 Pump: < 5.2 mm/s (> 200 kW) < 4.2 mm/s (<= 200kW) (ISO 10816-7)

Test Instrument	Manufacturer	Model	Serial No.	Calibration Certificate no.	Expiry Date
1					
2					

Remarks: _____
 Tested by: _____ Date: _____
 (Signature) (Name in block letter)
 Witnessed by: _____ Date: _____
 (Signature) (Name in block letter)
 Witnessed by: _____ Date: _____
 (Signature) (Name in block letter)