

THE ENGINEERING EQUIPMENT AND MATERIALS USERS ASSOCIATION

SEAL-LESS CENTRIFUGAL PUMPS: CLASS 1

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THE ENGINEERING EQUIPMENT AND MATERIALS USERS ASSOCIATION

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The Association aims to reduce members' costs by providing the opportunity for them to share resources and expertise in order to keep abreast of technological developments and improve the effectiveness and efficiency of their engineering activities. EEMUA supports the British Standards Institution, works with other institutions, associations, government departments, regulatory authorities and the Confederation of British Industry, and is also actively involved with other standards-making bodies, both national and international, such as the American Petroleum Institute.

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THE ENGINEERING EQUIPMENT AND MATERIALS USERS ASSOCIATION

Seal-less centrifugal pumps: Class 1

EEMUA PUBLICATION No 164 : 1993

Comparison between EEMUA Publication 164 and API Standard 685

AMENDMENT DATED MAY 2002

Overall comment

The vast majority of the requirements of EEMUA 164 are also required in API 685, in many cases using identical wording. Specific requirements of EEMUA that are not included in API or are only required "when specified" are listed below

Specific requirements of EEMUA 164 not in API 685 (listed in order of the relevant EEMUA paragraph)

1.1 Scope EEMUA covers canned-motor, wet-winding and magnetic-drive types. API only specifically covers canned-motor and magnetic-drive types. However there are very few requirements in EEMUA that are specific to the wet-winding type.

Also EEMUA suggests the use of ISO 5199 for lesser duty pumps - API makes no such suggestion. Note: ISO 5199 covers Class 2 centrifugal pumps in general. There is now an ISO standard (ISO 15783) for Class 2 seal-less pumps, which is current at the final ballot stage.

2.1.9 EEMUA prohibits ring section type pumps. API makes no mention of such pumps.

2.6.1 EEMUA requires internal bearings to be capable of 25000 hours continuous operation. API has no such quantitative requirement.

2.6.2 EEMUA requires the vendor to submit curves showing the variation in axial load - API does not.

2.8.2 EEMUA requires terminal boxes on wet-winding pumps to be designed to prevent the leakage of pumped fluids along the cabling. API does not cover wet-winding pumps.

2.9.2 EEMUA requires the completely assembled rotor to be dynamically balanced - API does not.

2.10.2 EEMUA requires magnetic couplings to tolerate temperatures up to 100°C or 20°C above the maximum pumping temperature, whichever is greater. API has no such specific requirement.

2.12.1 EEMUA requires flexible element couplings to be designed to retain the spacer in the event of flexible element failure. API has no such requirement.

2.15.6 EEMUA prohibits threaded connections in auxiliary pipework for flammable or toxic fluids. API does not unless specified.

2.16.2 EEMUA mandates more protective instrumentation than API.

3.2.1 EEMUA requires the vendor to propose the extent and type of surface or sub-surface examination. API invites the purchaser to specify this.

3.3.2.1 EEMUA specifies a minimum hydrostatic test pressure of 1.4 bar. API does not.

3.3.3.2 EEMUA requires the pump performance to be determined on test in accordance with ISO 2548. API makes no reference to any test code.

3.3.5 EEMUA requires a torque test on magnetic couplings. API only does so if specified.

Appendix A In this Appendix the EEMUA standard provides guidelines for the application of seal-less pumps. API has no such guide.

EEMUA

23 May 2002

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SECTION 1 - GENERAL

1.1 Scope

This standard defines the minimum requirements for seal-less centrifugal pumps (canned motor, wet winding and magnetic drive types) for use where safety, reliability and environmental performance are critical. It is envisaged that it would be applied in the petroleum, petrochemical and chemical industries. It is presented in the format of an API standard and uses selected clauses from API 610.

It is intended to cover applications for which any of the following parameters are exceeded.

Discharge pressure 16 barg
Pumping temperature 150°C
Drivers rated power 75 KW

It may be used when none of these parameters are exceeded, but a standard based on ISO 5199 will normally be more appropriate for such applications.

Guidelines for the Application of Seal-less Centrifugal Pumps are given in Appendix A.

1.2 Purchaser' Requirements

A round bullet (o) at the beginning of a paragraph indicates that either a decision is required, or further information is to be provided by the purchaser.

1.3 Conflicting Requirements

In the case of conflict between this standard and the inquiry or order, the order of precedence shall be:

- a) Local authority or statutory regulations.
- b) The equipment requisition or purchaser order and data sheets.
- c) This EEMUA Publication.
- d) Other industry, international and national standards.

1.4 Alternative Designs

This EEMUA standard refers to international and national standards which are widely accepted. Standards of the country where the equipment is manufactured and/or operated will be considered, and may be accepted where they can be used to achieve an equivalent technical result.

1.5 Definition of Terms

Terms used in this standard are defined as follows:

1.5.1 Normal operating point is the point at which usual operation is expected.

1.5.2 Rated operating point is the point at which the vendor certifies that performance is within the tolerances stated in this standard.

Performance includes the following factors: capacity, total head, power, efficiency, net positive suction head required, rotative speed, rated suction pressure, and the specific gravity and viscosity of the pumped liquid.

1.5.3 Maximum allowable working pressure of the casing is the greatest discharge pressure at the specified pumping temperature which the design of the pump casing will allow.

1.5.4 Maximum discharge pressure is the maximum suction pressure plus the maximum differential pressure that the pump is able to develop when operating with the furnished impeller at the specified speed, specific gravity, and pumping temperature.

1.5.5 Maximum continuous speed is the speed at least equal to 105 percent of the highest speed required by any of the specified operating conditions.

1.5.6 Trip speed is the speed at which the independent emergency overspeed device operates to shut-down a prime mover.

1.5.7 Minimum continuous stable flow is the lowest flow at which the pump can operate without exceeding the noise and vibration limits imposed by this standard.

1.5.8 Minimum continuous thermal flow is the lowest flow at which the pump can operate without its operation being impaired by the temperature rise of the pumped liquid.

1.5.9 Pressure casing is the composite of all stationary pressure-containing parts of the unit, including all nozzles, motor casing, terminal box, magnetic drive housing, filters, coolers, pipework and other parts integral to the pump.

1.5.10 Net positive suction head (NPSH) is the total suction pressure of liquid (absolute), determined at the suction nozzle and referred to the datum elevation, minus the vapour pressure of the liquid (absolute) expressed as head of the pumped fluid. The datum elevation is the pump centerline for horizontal pumps, the suction nozzle centerline for vertical in-line pumps, and the top of the foundation for other vertical pumps.

1.5.11 Net positive suction head available (NPSHA) is the NPSH of liquid, determined by the purchaser for the pumping system.

1.5.12 Net positive suction head required (NPSHR) is the NPSH determined by vendor testing, usually with water. NPSHR is the minimum NPSH required to prevent more than 3 percent head drop (first-stage head in multistage pumps) due to cavitation within the pump.

SECTION 2 - BASIC DESIGN

2.1 General

2.1.1 The equipment (including auxiliaries) covered by this standard shall be designed and constructed for a minimum service life of 20 years.

2.1.2 The vendor shall assume responsibility for the engineering coordination of the equipment and all ancillary systems included in the scope of order. In cases where the pump vendor supplies equipment that he has not manufactured, he shall ensure that the designs of these are compatible with each other and with his own equipment in all respects. The satisfactory functioning of the complete unit shall form part of the pump vendor's guarantee.

2.1.3 Pumps with constant-speed drivers shall be capable of at least a 5 percent head increase at rated conditions by replacement of the impeller of impellers with ones of increased diameter or different hydraulic design.

2.1.4 Pumps with variable speed drivers shall be capable of operating continuously up to at least 105% of rated speed and shall be capable of operating briefly, under emergency conditions up to trip speed.

2.1.5 The vendor shall specify on the data sheets the NPSHR when the pump is operated on water at the rated capacity and rated speed. A hydrocarbon reduction or correction factor shall not be applied.

2.1.6 Pumps that handle liquids more viscous than water shall have their performance corrected in accordance with the Centrifugal Pump Section of the Hydraulic Institute Standards. Additional corrections may be necessary for viscosity effects on motors or magnetic couplings. The vendor shall provide details of all such corrections.

- o 2.1.7 Pumps shall have stable head/capacity curves that continuously rise to shut off. When parallel operation is specified the head rise from rated operating point to minimum stable flow, for one and two-stage pumps shall be 10-20 percent of the head at rated capacity.

2.1.8 Pumps shall be selected such that the best efficiency occurs at a flow close to the normal operating point.

2.1.9 Pumps with ring section casings and external tie bolts shall not be used for flammable or toxic fluids.

- o 2.1.10 Noise limits will normally be specified in the enquiry. However in the absence of such requirements, noise levels at 1 m from the pump set shall not exceed 85 dB(A).

2.1.11 Jacket cooling systems shall be designed to positively prevent the process stream from leaking into the coolant. Coolant passages shall not open into casing joints.

- o 2.1.12 Motors, electrical components, and electrical installations shall be suitable for the area classification (class, group and division) specified by the purchaser on the data sheets as well as any applicable local codes.

2.2 Pressure Casings

2.2.1 The stress used in design for any given material shall not exceed that given in BS 5500, Section 2, or ASME Section VIII, Division 1. For cast material, the factor specified in the code shall be applied.

2.2.2 The pressure casing shall be designed for the maximum allowable working pressure at the pumping temperature and for the hydrostatic test pressure at ambient temperature. The maximum allowable working pressure shall not be less than the maximum discharge pressure plus allowances for head and speed increases (see 2.1.3 and 2.1.4).

Pressure containing parts shall have a corrosion allowance of at least 3mm, or shall be backed by a secondary containment envelope (see 2.8.1 and 2.10.3).

2.2.3 The maximum allowable working pressure shall apply to all parts referred to in the definition of pressure casing (see 1.5.9).

2.2.4 The pump pressure casing shall be capable of withstanding double the range of forces and moments in Table 1 applied simultaneously to the pump through each nozzle, when at rated conditions, without distortion that would impair operation of the pump.

NOZZLE LOADINGS - TABLE 1

Note: Nozzle loadings, Table 1. Each value shown below indicates a range from minus that values; or example, 710 indicates a range from - 710 to + 710

METRIC	Nominal Size of Nozzle Flange (inches)					
	2	3	4	6	8	10
NOZZLE POSITION	FORCE ACTING ON NOZZLE - Newtons					
Each top nozzle						
FX	710	1100	1400	2500	3800	5300
FY	890	1300	1800	3100	4900	6700
FZ	580	890	1200	2100	3100	4500
FR	1300	1900	2500	4500	6900	9800
Each end nozzle						
FX	710	1100	1400	2500	4900	6700
FY	580	890	1200	2100	3100	4500
FZ	890	1300	1800	3100	3800	5300
FR	1300	1900	2500	4500	6900	9800
Each side nozzle						
FX	890	1300	1800	3100	4900	6700
FY	580	890	1200	2100	3100	4500
FZ	710	1100	1400	2500	3800	5300
FR	1300	1900	2500	4500	6900	9800
	MOMENT ACTING ON NOZZLE - Newton-Metres					
Each nozzle						
MX	460	950	1300	2300	3500	5000
MY	350	720	1000	1800	2600	3900
MZ	230	470	680	1200	1800	2400
MR	420	1300	1800	3100	4700	6800

IMPERIAL	Nominal Size of Nozzle Flange (inches)					
	2	3	4	6	8	10
NOZZLE POSITION	FORCE ACTING ON NOZZLE - Pounds					
Each top nozzle						
FX	160	240	320	560	850	1200
FY	200	300	400	700	1100	1500
FZ	130	200	260	460	700	1000
FR	290	430	570	1010	1560	2200
Each end nozzle						
FX	160	240	320	560	850	1200
FY	130	200	260	460	700	1000
FZ	200	300	400	700	1100	1500
FR	290	430	570	1010	1560	2200
Each side nozzle						
FX	200	300	400	700	1100	1500
FY	130	200	260	460	700	1000
FZ	160	240	320	560	850	1200
FR	290	430	570	1010	1560	2200
	MOMENT ACTING ON NOZZLE - Foot Pounds					
Each nozzle						
MX	340	700	980	1700	2600	3700
MY	260	530	740	1300	1900	2900
MZ	170	350	500	870	1300	1800
MR	460	950	1300	2310	3500	5000

NOTE; See figures 1 to 4 for orientation X Y Z (R = Resultant)

COORDINATE SYSTEM FOR FORCES AND MOMENTS - Diagrams referring to Table 1

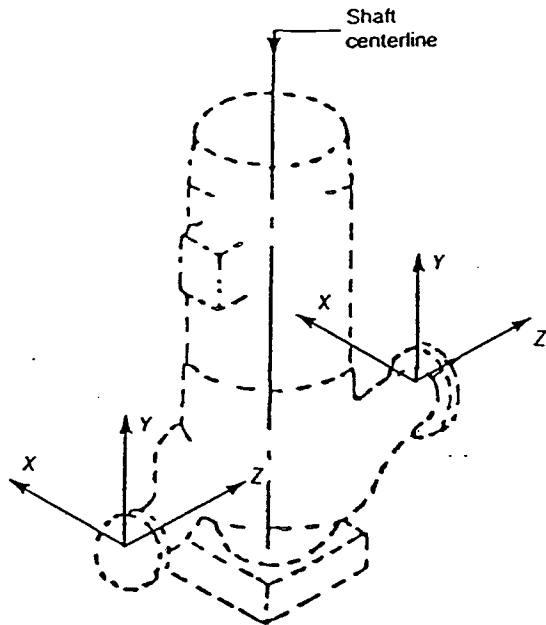


Figure 1: Coordinate System for the Forces and Moments in Table 1. Vertical In-Line Pumps.

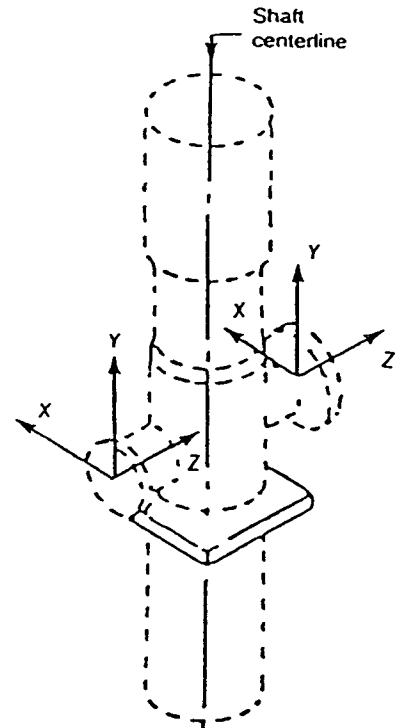


Figure 2: Coordinate system for the forces and Moments in Table 1. Vertical Double Casing Pumps.

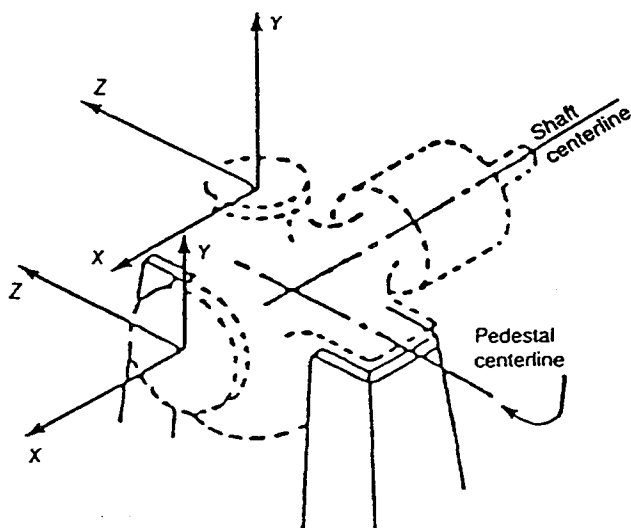


Figure 3: Coordinate System for the Forces and Moments in Table 1. Horizontal Pumps with End Suction and Top Discharge Nozzles.

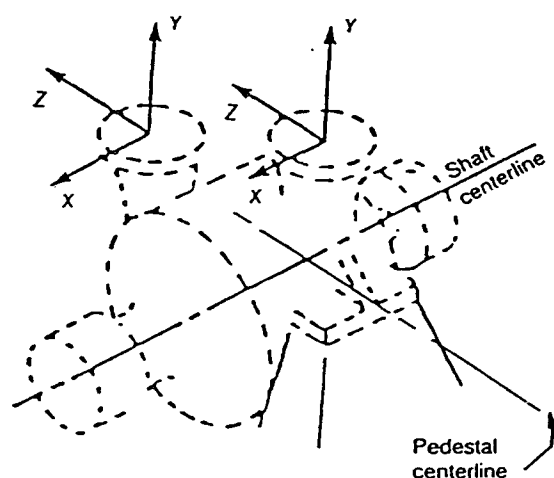


Figure 4: Coordinate system for the forces and Moments in Table 1. Horizontal Pumps with Top Discharge Nozzles.

2.3 Pressure Casing Connections

2.3.1 Suction and discharge nozzles shall be flanged and shall be of equal rating.

2.3.2 Flanges shall be full or spot faced on the back and shall be designed for through bolting.

2.3.3 Auxiliary connections shall be at least DN15 (NPS ½) for pumps with discharge nozzle openings DN50 (NPS 2) or smaller, and at least DN20 (NPS ¾) for pumps with discharge nozzle openings larger than DN50 (NPS 2).

2.3.4 For flammable or toxic liquids, auxiliary connections to the pressure casing shall be socket welded, butt welded, flanged or machined and studded. Purchaser connections shall be flanged.

2.3.5 Connections welded to the casing shall meet the material requirements of the casing, including impact values, rather than the requirements of the connected piping.

2.3.6 Pumps shall be provided with valved vent and drain connections. Vent connections may be omitted if the pump is made self venting by the arrangement of the nozzles.

2.4 Rotating Elements

2.4.1 Impellers shall be positively secured against circumferential and axial movement. An interference fit is not considered a positive locking method. Pinning of impellers is not acceptable.

2.5 Wear Rings

2.5.1 Casing shall be fitted with renewable wear rings.

2.5.2 Renewable casing bushings or the equivalent, shall be provided at all interstage points.

2.5.3 Mating wear surfaces of hardenable materials shall have a difference in Brinell hardness number of at least 50, unless both the stationary and the rotating wear surfaces have Brinell hardness number of at least 400.

2.6 Internal Bearings

2.6.1 Bearing shall be capable of operation continuously for a minimum of 25,000 hours at any operating point between minimum stable flow and the rated operating point.

Rolling element bearings shall be selected to give a minimum L-10 rating life of 3 years (25,000 hours) in continuous operation at rated pump conditions.

The pump vendor shall provide evidence that the specified lives can be achieved with the predicted bearing loads recognising the lubricating properties of the pumped fluid.

2.6.2 Axial loads shall be determined for all specified operating conditions (including maximum differential pressure) with both design internal clearances and two times design internal clearances. Thrust bearings shall be sized for continuous operation with the maximum load as determined above.

For pumps with rated power in excess of 75 KW, the pumps vendor shall submit, with his bid, curves showing the variation of axial load with capacity (zero to 125% rated flow) for design and two times design internal clearances.

2.6.3 Bearings shall be designed to tolerate inadvertent reverse rotation of the pump.

2.6.4 Bushes and sleeves forming journal bearings shall be positively secured in the axial direction and shall be prevented from rotation relative to the component on which they are mounted.

2.6.5 Silicon Carbide sleeves, and other materials with low coefficients of thermal expansion, shall have a radial clearance sufficient to accommodate relative thermal expansions at the maximum operating temperature specified on the pump data sheet.

2.6.6 Where the pumped fluid is likely to crystallise at ambient temperature bearings shall be provided with an external flush.

2.7 Drivers

2.7.1 Motor drivers shall have power ratings, including the service factor, if any, at least equal to the percentages of power at pump rated conditions given below.

Pump Rated Power Kilowatts	Motor Nameplate Rating as Percentage of rated Pump Power
Less than 25	125
25 - 50	115
Above 50	110

2.7.2 The power margins specified in clause 2.7.1 shall be provided after allowing for viscous and eddy current losses in magnetic couplings.

2.7.3 Motor drivers shall accelerate to full speed within a period of not more than 15 seconds with 80% normal voltage.