

DRAFT API 685-2<sup>ND</sup> ED. "SEALLESS PUMPS"

American Petroleum Institute  
1220 L Street, Northwest  
Washington, DC 20005

COMMITTEE: S.O.M.E., API 685 TASK FORCE

CHAIRMAN: Jim Bryant

MEETING: Meeting # 10 Review

TIME: 8::00 – 10:00am

DATE: 16-FEB-2006

(M) TF Member

(R) Alternate or Representing a Member

(V) Visitor

(S) API Staff

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(persons in **bold** participated in this meeting)

**HIGHLIGHTS:**

No.	Item Description	Action By	Date Req'd
1.	This meeting was held to review some specific topics for resolution and incorporation into the final API 685 draft.	Information	
2.	Para 6.3.8 – It was agreed that the default position for API 685 should remain for centerline supported MDPs for temperatures of approximately 175 C and higher. The point is not applicable to CMP designs.	Information	
3.	Para 6.8 regarding secondary control / containment was discussed. The final decision was to add some wording to the cover "primary" leakage and confirm the figures in the final draft.	Information	
4.	Para 8.3.1.2 was placed on hold pending resolution of ISO 9906 and application to ISO 13709.	Information	
5.	The incorporation of close coupled MDPs need to be considered. General power limit for these would be 27 kW (40 hp) and below.	All	30APR06
6	Next meeting will be scheduled for 30-APR-2006, at the API S.O.M.E. meeting in Dallas, TX with a start time of <b>8:00 AM</b> - to appx. <b>12:00 PM</b> .	All	30APR06

API 685 First Edition	Source	Proposed Revision	Reason for Change
<b>6.2 CRITICAL DESIGN AND APPLICATION CONSIDERATIONS</b>			

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<p>6.2.1 Properties of the fluid being pumped are critical to the performance of the pump. The purchaser and vendor have a responsibility to transfer information to each other. The purchaser will furnish information including but not limited to the following: NPSHA, temperature/vapor pressure curve, temperature/viscosity curve, specific heat, specific gravity, thermal conductivity, thermal expansion, and polymerization characteristics. The purchaser will also furnish information on any solids present including particle size, percent, and distribution. The vendor shall furnish information including, but not limited to, the following: NPSHR, temperature rise based on fluid being pumped, both during operation and after shutdown, effect of wear, minimum continuous stable flow, and minimum continuous thermal flow.</p>		<p>Properties of the fluid being pumped are critical to the performance of the pump. The purchaser and vendor have a responsibility to transfer information to each other. The purchaser will furnish information including but not limited to the following: NPSHA, temperature/vapor pressure curve, temperature/viscosity curve, specific heat, specific gravity, thermal conductivity, thermal expansion, and polymerization characteristics. The purchaser will also furnish information on any solids present including particle size, percent, and distribution. The vendor shall furnish information including, but not limited to, the following: NPSHR, temperature rise based on fluid being pumped <b>at minimum flow/rated/end of curve and</b> during operation and after shutdown, effect of wear, minimum continuous stable flow, and minimum continuous thermal flow.</p> <p><b>Include gas entrainment</b></p>	<p>It is important that the liquid remain a fluid at all points in the pump and at all operating conditions.</p> <p><b>Define "end of curve"</b></p> <p><b>Include "entrained gas" on data sheets</b></p>
<p>6.2.2 Proper pump design and selection are dependent on knowledge of the purchaser's system. The purchaser will furnish information including, but not limited to, pump location, suction vessel and piping arrangement.</p>			
<p><b>6.8 SECONDARY CONTROL/CONTAINMENT</b></p>			
<p>6.8.1 The purchaser will specify which of the following control/containment options the pump</p>			

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shall have:			
a. Secondary control design (3.65).			
		<u>Secondary control with provision for leakage monitoring device(s) (Secondary control system 3.66).</u>	Monitoring or detecting??  3.6.3 & 3.6.4 need revision to make provision non-mandatory
b. Secondary control with leakage monitoring device(s) (Secondary control system 3.66).			
c. Secondary containment design (3.63).		Secondary containment design (3.63). Recommended for all toxic, hazardous or flammable services	Table for now. Further clarification Define terms???
		<u>Secondary containment with provision for leakage monitoring device(s)</u>	
d. Secondary containment with leakage monitoring device(s) (Secondary containment system 3.64).			Leakage rate of secondary containment system: The quality of the secondary containment system should be described more detailed. What leakage rates are acceptable?  Add note on quantity from 682??  Where does Mech seal fall - containment or control???
6.8.2 The secondary control system shall have a stand-by life of at least 25,000 hours in a pump operating mode and shall have a functional life of at least 24 hours in the event of containment shell failure.		The secondary control system shall have a stand-by life of at least 25,000 hours in a pump operating mode and shall have a functional life of at least 24 hours in the event of a <b>primary</b> containment shell failure	

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6.8.3 When specified, the vendor shall provide the maximum flow rate from the secondary control system in the event of containment shell or stator liner failure.			
6.8.4 The secondary control/containment system shall be rated for the same pressure as the pressure casing. Provisions for monitoring shall be included in the secondary control/containment system.		6.8.4 The secondary control/containment system shall be rated for the same pressure as the pressure casing.	Two suggestions: a) When specified, provisions for monitoring shall be included in the secondary control/containment system. b) No changes to this paragraph - 6.8.1 provides option for both
6.8.5 Material of the secondary pressure casing(s) shall be carbon steel as a minimum.			
6.8.6 Secondary pressure casings are by definition pressure containing components and shall meet the requirements of 6.3.			
6.8.7 All secondary control and containment system joints shall be rabbeted and sealed with controlled compression gasket(s), sealed with O-rings of material compatible with the process liquid, or welded.		6.8.7 All secondary control and containment system joints shall be rabbeted and sealed with controlled compression gasket(s), sealed with O-rings of material compatible with the process liquid, or welded. <b>Not required for canned motor pumps</b>	The stator assemblies of canned motor pumps are not fabricated to this design.
6.8.8 When specified, drain connections shall be provided which completely drain and provide the capability to flush all internal areas of the secondary pressure casing.		When specified, drain <b>and flush</b> connections shall be provided which <b>completely</b> drain and provide the capability to flush all internal areas of the secondary pressure casing.	It may be impossible to completely drain the stator assembly of canned motor pumps.
<b>9 Specific Pump Sections</b>		<b>9 Specific Pump Sections</b>	
<b>9.1 MAGNETIC DRIVE PUMPS</b>		<b>9.1 MAGNETIC DRIVE PUMPS</b>	
<b>9.1.1 General</b>		<b>9.1.1 General</b>	

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			<p>Close coupled MDP configuration: We recommend to incorporate the use of a close coupled configuration.</p> <p>Table: Identify impact on all other paragraphs</p>
			<p>Journal bearing materials: We recommend to consider the addition of a requirement to evaluate bearing materials for low lubricity fluids. (added paragraph 6.10.10)</p>
<p>9.1.1.1 Magnetic Drive Pumps are designated as Type MDP. A description of Type MDP pumps is given in Appendix C.</p>		<p>9.1.1.1 Magnetic Drive Pumps are designated as Type MDP. A description of Type MDP pumps is given in Appendix C.</p>	
<p>9.1.1.2 The design clearance of the liquid gap and of the air gap shall be sufficient to ensure that contact between the magnet assemblies and the containment shell does not occur due to pressure deformation, nozzle loading, flow variations, thermal expansion or power end bearing wear.</p>		<p>9.1.1.2 The design clearance of the liquid gap and of the air gap shall be sufficient to ensure that contact between the magnet assemblies and the containment shell does not occur due to pressure deformation, nozzle loading, flow variations, thermal expansion or power end bearing wear.</p>	
<p>9.1.1.3 The design shall allow for the inspection of the containment shell without disturbing the pressure casing.</p>		<p>9.1.1.3 The design shall allow maintaining the magnet carrier and drive frame for the inspection of the containment shell without disturbing the pressure casing.</p>	<p>9.1.1.3 Inspection of isolation shell: Inspection of the isolation shell from outside does not provide reliable information about the condition of the shell. Most damages occur from the inside. Our suggestion is: eliminate this paragraph. Make sure mag carrier can be maintained without breaching containment? MDG to investigate</p>

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9.1.1.4 When specified, the design shall provide for the removal of the drive end without disturbing the pressure casing or the pump driver (i.e., adequate spacer coupling provided) (see 4.3.6).		9.1.1.4 When specified, the design shall provide for the removal of the drive end without disturbing the pressure casing or the pump driver (i.e., adequate spacer coupling provided) (see 4.3.6).	
9.1.1.5 Product lubricated bearings shall not be supported by the containment shell.		9.1.1.5 Product lubricated bearings shall not be supported by the containment shell.	
9.1.1.6 Jackscrews, guide rods, or similar devices shall be incorporated in the design to facilitate installation and maintenance of the magnet coupling.		9.1.1.6 Jackscrews, guide rods, or similar devices shall be incorporated in the design to facilitate installation and maintenance of the magnet coupling.	
9.1.1.7 Cooling and lubrication of product lubricated bearings and magnet area shall be in accordance with Appendix D.		9.1.1.7 Cooling and lubrication of product lubricated bearings and magnet area shall be in accordance with Appendix D.	
9.1.1.8 The torque rating of the magnetic coupling and the antifriction bearing manufacturer's identity numbers shall appear on the pump nameplate or on a supplemental nameplate meeting the requirements of 6.15.2		9.1.1.8 The torque rating of the magnetic coupling and the antifriction bearing manufacturer's identity numbers shall appear on the pump nameplate or on a supplemental nameplate meeting the requirements of 6.15.2	
<b>9.1.2 Pressure Containment</b>		<b>9.1.2 Pressure Containment</b>	
9.1.2.1 CONTAINMENT SHELL		9.1.2.1 CONTAINMENT SHELL	<p><b>Non-metallic isolation shell:</b>                      We agree that a non-metallic isolation shell should be listed as optional choice for the end-user.</p> <p>Table to see what 13709 is doing.</p>
9.1.2.1.1 The containment shell is by definition a pressure containing component and shall meet the requirements of 6.3 except as follows:		9.1.2.1.1 The containment shell is by definition a pressure containing component and shall meet the requirements of 6.3 except as follows:	

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a. Section VIII, Division 2, of the ASME Boiler and Pressure Vessel Code may be utilized in lieu of Division 1 for design.		a. Section VIII, Division 2, of the ASME Boiler and Pressure Vessel Code may be utilized in lieu of Division 1 for design.	
b. The minimum corrosion/erosion allowance shall be 0.4 mm (0.015 in.).		b. The minimum corrosion/erosion allowance shall be 0.4 mm (0.015 in.).	
c. The minimum containment shell thickness shall be 1.0 mm (0.040 in.).		c. The minimum containment shell thickness shall be 1.0 mm (0.040 in.).	
9.1.2.1.2 Fabrication of containment shells shall conform with 6.13.		9.1.2.1.2 Fabrication of containment shells shall conform with 6.13.	
9.1.2.1.3 The containment shell to casing cover joint shall have a metal-to-metal rabbeted fit utilizing a confined controlled compression gasket of material compatible with the process fluids and operating temperatures.		9.1.2.1.3 The containment shell to casing cover joint shall have a metal-to-metal rabbeted fit utilizing a confined controlled compression gasket of material compatible with the process fluids and operating temperatures.	
9.1.2.1.4 Alternative containment shell designs are subject to approval by the purchaser.		9.1.2.1.4 Alternative containment shell designs are subject to approval by the purchaser.	
9.1.2.2 SECONDARY CONTROL SYSTEM		9.1.2.2 SECONDARY CONTROL SYSTEM	
9.1.2.2.1 The secondary control system shall protect the antifriction bearings from contamination by the pumped fluid.		9.1.2.2.1 The secondary control system shall protect the antifriction bearings from contamination by the pumped fluid.	
9.1.2.2.2 To minimize leakage around the external shaft in the event of a primary containment failure, the secondary control system shall include a replaceable, non-sparking restriction device. Lip seals are not acceptable.		9.1.2.2.2 To minimize leakage around the external shaft in the event of a primary containment failure, the secondary control system shall include a replaceable, non-sparking restriction device. Lip seals are not acceptable.	
<b>9.1.3 Magnetic Couplings</b>		<b>9.1.3 Magnetic Couplings</b>	
9.1.3.1 Magnetic coupling assemblies shall be of either synchronous or asynchronous design.		9.1.3.1 Magnetic coupling assemblies shall be of either synchronous or	

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<p>Synchronous couplings shall be supplied with rare earth magnets. Torque ring drive couplings may be supplied with either rare earth or aluminum nickel cobalt magnets. The vendor shall state the magnet material on the proposal datasheet (refer to Appendix B). Alternate designs and/or materials require purchaser approval for the specific application.</p>		<p>asynchronous design. Synchronous couplings shall be supplied with rare earth magnets. Torque ring drive couplings may be supplied with either rare earth or aluminum nickel cobalt magnets. The vendor shall state the magnet material on the proposal datasheet (refer to Appendix B). Alternate designs and/or materials require purchaser approval for the specific application.</p>	
<p>9.1.3.2 Magnets shall be mechanically retained and bonded with a suitable adhesive.</p>		<p>9.1.3.2 Magnets shall be mechanically retained and bonded with a suitable adhesive.</p>	
<p>9.1.3.3 The pump shall be designed to prevent the outer drive magnet from contacting the containment shell in the event of a shaft or bearing failure. The design shall utilize a replaceable device of nonsparking material to eliminate any sources of ignition.</p>		<p>9.1.3.3 The pump shall be designed to prevent the outer drive magnet from contacting the containment shell in the event of a shaft or bearing failure. The design shall utilize a replaceable device of nonsparking material to eliminate any sources of ignition.</p>	
<p>9.1.3.4 The outer drive rotor (outer magnet ring) shall be keyed to the power end drive shaft. A taper fit and puller holes are required for shaft sizes equal to or greater than 50 mm (2 in.).</p>		<p>9.1.3.4 The outer drive rotor (outer magnet ring) shall be keyed to the power end drive shaft. A taper fit and puller holes are required for shaft sizes equal to or greater than 50 mm (2 in.).</p>	
<p>9.1.3.5 The inside surface of the outer magnet ring shall be sheathed with a nonmagnetic material to prevent damage to the magnets or the containment shell upon assembly/disassembly.</p>		<p>9.1.3.5 The inside surface of the outer magnet ring shall be sheathed with a nonmagnetic material to prevent damage to the magnets or the containment shell upon assembly/disassembly.</p>	
<p>9.1.3.6 The inner magnet or torque ring material shall be shielded from the process fluid by a hermetically sealed metallic sheathing. This sheathing material must be compatible with the process fluid to ensure against chemical attack. The</p>		<p>9.1.3.6 The inner magnet or torque ring material shall be shielded from the process fluid by a hermetically sealed metallic sheathing. This sheathing material must be compatible with the</p>	

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<p>minimum inner magnet sheathing thickness shall be 0.40 mm (0.015 in.).</p>		<p>process fluid to ensure against chemical attack. The minimum inner magnet sheathing thickness shall be 0.40 mm (0.015 in.).</p>	
<p>9.1.3.7 Magnetic couplings shall be designed to avoid decoupling during start-up and while operating at rated conditions. The following conditions shall be analyzed by the manufacturer when sizing the magnetic coupling:</p>		<p>9.1.3.7 Magnetic couplings shall be designed to avoid decoupling during start-up and while operating at rated conditions. The following conditions shall be analyzed by the manufacturer when sizing the magnetic coupling:</p>	<p><b>Irreversible magnetic losses (hysteresis):</b>                      If magnet materials are subject to irreversible losses (hysteresis) due to heat exposure under operating conditions, these losses need to be considered by the manufacturer. Paragraph 4.2.2 of ISO 15783 mentions this. We recommend to incorporate a similar paragraph.                      Cover in this section - see 9.1.3.7 d. below</p>
<p>a. Torque required to accelerate the rotor assembly during start-up with the job driver and specified fluid. Starting conditions will be specified by the purchaser. Across-the-line starting is to be assumed for medium voltage motor drives unless otherwise specified.</p>		<p>a. Torque required to accelerate the rotor assembly during start-up with the job driver and specified fluid. Starting conditions will be specified by the purchaser. Across-the-line starting is to be assumed for medium voltage motor drives unless otherwise specified.</p>	
<p>b. Torque required to pump the fluid at rated conditions of flow, temperature, specific gravity and viscosity with provision to operate at a 5 percent increase in head for constant speed drivers or 5 percent increase in speed when variable speed drivers are applied.</p>		<p>b. Torque required to pump the fluid at rated conditions of flow, temperature, specific gravity and viscosity with provision to operate at a 5 percent increase in head for constant speed drivers or 5 percent increase in speed when variable speed drivers are applied.</p>	
<p>c. When specified, torque required to cover end of curve operation, such as transfer pumps, loading pumps, and pumps operating in parallel.</p>		<p>c. When specified, torque required to cover end of curve operation, such as transfer pumps, loading pumps, and pumps operating in parallel.</p>	
<p>Note: This sizing will result in higher losses, greater heat generation by the magnetic coupling,</p>		<p>Note: This sizing will result in higher losses, greater heat generation by the</p>	

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and an oversized coupling.		magnetic coupling, and an oversized coupling.	
		d. Irreversible magnetic losses at operating temperatures of the magnetic drive shall be considered by the manufacturer.	From ISO 15783 4.2.2 d)
9.1.3.8 The rated torque of the magnetic coupling shall equal the larger of the torques calculated in 9.1.3.7 (a), (b), or, when specified, (c), with factors applied as shown in Table 8. Where it appears that this will lead to unnecessary oversizing of the magnetic coupling, an alternative proposal shall be submitted for the purchaser's approval.		9.1.3.8 The rated torque of the magnetic coupling shall equal the larger of the torques calculated in 9.1.3.7 (a), (b), or, when specified, (c), with factors applied as shown in Table 8. Where it appears that this will lead to unnecessary oversizing of the magnetic coupling, an alternative proposal shall be submitted for the purchaser's approval.	
9.1.3.9 When specified, the vendor shall submit a torque versus temperature curve that covers the entire design temperature range of the magnetic coupling.		9.1.3.9 When specified, the vendor shall submit a torque versus temperature curve that covers the entire design temperature range of the magnetic coupling.	
9.1.3.10 When specified, the vendor shall submit a speed-torque curve defining capability of the synchronous magnetic coupling during start-up and operation at the rated temperature. The torque requirements of 9.1.3.7 (a) and (b) are to be shown as well as the rating factor defined in 9.1.3.8. The speed-torque curve shall be presented in the format shown in Figure 7.		9.1.3.10 When specified, the vendor shall submit a speed-torque curve defining capability of the synchronous magnetic coupling during start-up and operation at the rated temperature. The torque requirements of 9.1.3.7 (a) and (b) are to be shown as well as the rating factor defined in 9.1.3.8. The speed-torque curve shall be presented in the format shown in Figure 7.	
9.1.4 Antifriction Bearings, Bearing Housings, and Lubrication		9.1.4 Antifriction Bearings, Bearing Housings, and Lubrication	
9.1.4.1 Antifriction Bearings		9.1.4.1 Antifriction Bearings	Review for consistency with ISO 13709
9.1.4.1.1 Antifriction rolling element bearings shall be used to support the external drive shaft such that		9.1.4.1.1 Antifriction rolling element bearings shall be used to support the	

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the following conditions are satisfied:		external drive shaft such that the following conditions are satisfied:	
a. Factor N <sub>dm</sub> shall not exceed 500,000		a. Factor N <sub>dm</sub> shall not exceed 500,000	
<p>Where</p> <p>dm = mean bearing diameter (d+D)/2, mm,</p> <p>N = rotative speed, rpm</p>		<p>Where</p> <p>dm = mean bearing diameter (d+D)/2, mm,</p> <p>N = rotative speed, rpm</p>	
b. Basic rating L <sub>10</sub> per ISO 281 (ANSI/ABMA Standard 9) shall be at least 25,000 hours with continuous operation at rated conditions, and at least 16,000 hours with maximum radial and axial loads at rated speed.		b. Basic rating L <sub>10</sub> per ISO 281 (ANSI/ABMA Standard 9) shall be at least 25,000 hours with continuous operation at rated conditions, and at least 16,000 hours with maximum radial and axial loads at rated speed.	
9.1.4.1.2 Antifriction rolling element bearings selected to support axial thrust loads shall be sized for continuous operation under all specified conditions. In addition to thrust from rotor and any internal gear reactions due to the most extreme allowable conditions, the axial force transmitted through flexible couplings shall be considered a part of the duty.		9.1.4.1.2 Antifriction rolling element bearings selected to support axial thrust loads shall be sized for continuous operation under all specified conditions. In addition to thrust from rotor and any internal gear reactions due to the most extreme allowable conditions, the axial force transmitted through flexible couplings shall be considered a part of the duty.	
9.1.4.1.3 For gear-type couplings, the external force shall be calculated from the following formula:		9.1.4.1.3 For gear-type couplings, the external force shall be calculated from the following formula:	
(1)		(1)	
In U.S. units:		In U.S. units:	

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<p>Where</p> <p>F = external force, kN (lbs),</p> <p>Pr = rated power, kW (hp),</p> <p>Nr = rated speed, in revolutions per minute,</p> <p>D = shaft diameter at the coupling, mm (in.).</p>		<p>Where</p> <p>F = external force, kN (lbs),</p> <p>Pr = rated power, kW (hp),</p> <p>Nr = rated speed, in revolutions per minute,</p> <p>D = shaft diameter at the coupling, mm (in.).</p>	
<p>Note: Shaft diameter is an approximation of the coupling pitch radius.</p>		<p>Note: Shaft diameter is an approximation of the coupling pitch radius.</p>	
<p>9.1.4.1.4 Thrust forces for flexible metal element couplings shall be calculated on the basis of the maximum allowable deflection permitted by the coupling manufacturer.</p>		<p>9.1.4.1.4 Thrust forces for flexible metal element couplings shall be calculated on the basis of the maximum allowable deflection permitted by the coupling manufacturer.</p>	
<p>9.1.4.1.5 Rolling element bearings shall be located on the shaft using shoulders, collars, or other positive locating devices; snap rings and spring-type washers are not acceptable. Rolling element bearings shall be retained on the shaft with an interference fit and fitted into the housing with a diametrical clearance, both in accordance with the recommendations of ISO 286 (ANSI/ABMA Standard 7). sBearings shall be mounted directly on the shaft; bearing carriers are not acceptable. The device used to lock ball thrust bearings to shafts shall be restricted to a nut with a tongue-type lock washer.</p>		<p>9.1.4.1.5 Rolling element bearings shall be located on the shaft using shoulders, collars, or other positive locating devices; snap rings and spring-type washers are not acceptable. Rolling element bearings shall be retained on the shaft with an interference fit and fitted into the housing with a diametrical clearance, both in accordance with the recommendations of ISO 286 (ANSI/ABMA Standard 7). sBearings shall be mounted directly on the shaft; bearing carriers are not acceptable. The device used to lock ball thrust bearings to shafts shall be restricted to a nut with a tongue-type lock washer.</p>	

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<p>9.1.4.1.6 Except for the angular contact type, rolling element bearings shall have greater than Normal internal clearance according to ISO 5753 Group 3 (ANSI/ABMA Symbol 3, as defined in ANSI/ABMA Standard 20). Single- or double-row bearings shall be of the Conrad type (no filling slots).</p>		<p>9.1.4.1.6 Except for the angular contact type, rolling element bearings shall have greater than Normal internal clearance according to ISO 5753 Group 3 (ANSI/ABMA Symbol 3, as defined in ANSI/ABMA Standard 20). Single- or double-row bearings shall be of the Conrad type (no filling slots).</p>	
<p>9.1.4.2 ANTIFRICTION BEARING HOUSINGS</p>		<p>9.1.4.2 ANTIFRICTION BEARING HOUSINGS</p>	
<p>9.1.4.2.1 Bearing housings for oil-lubricated nonpressure-fed bearings shall be provided with tapped and plugged fill and drain openings at least 1/2 NPS. The housings shall be equipped with constant level sight feed oilers at least 0.12 liter (4 oz) in size, with a positive level positioner (not an external screw), heat-resistant glass containers, and protective wire cages. When specified, the oilers shall meet the purchaser's preference. Means shall be provided for detecting overfilling of the housings. A permanent indication of the proper oil level shall be accurately located and clearly marked on the outside of the bearing housing with permanent metal tags, marks inscribed in the castings, or other durable means.</p>		<p>9.1.4.2.1 Bearing housings for oil-lubricated nonpressure-fed bearings shall be provided with tapped and plugged fill and drain openings at least 1/2 NPS. The housings shall be equipped with constant level sight feed oilers at least 0.12 liter (4 oz) in size, with a positive level positioner (not an external screw), heat-resistant glass containers, and protective wire cages. When specified, the oilers shall meet the purchaser's preference. Means shall be provided for detecting overfilling of the housings. A permanent indication of the proper oil level shall be accurately located and clearly marked on the outside of the bearing housing with permanent metal tags, marks inscribed in the castings, or other durable means.  <b>Internal surfaces of bearing housings and carbon steel oil-systems components shall be coated with an oil-soluble rust preventive that is compatible with the lubricating oil</b></p>	<p><b>BN Added requirement from 8.4.3.4</b></p>
<p>9.1.4.2.2 Sufficient cooling, including allowance for fouling, shall be provided to maintain the oil sump temperature below 82°C (180°F) for ring-oiled or splash systems, based on the specified</p>		<p>9.1.4.2.2 Sufficient cooling, including allowance for fouling, shall be provided to maintain the oil sump temperature below 82°C (180°F) for ring-oiled or</p>	

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operating conditions and ambient temperature of 43°C (110°F). During shop testing, the oil sump temperature rise shall not exceed 39°C (70°F).		splash systems, based on the specified operating conditions and ambient temperature of 43°C (110°F). During shop testing, the oil sump temperature rise shall not exceed 39°C (70°F).	
Note: Pumps equipped with ring-oiled or splash lubrication systems may not reach temperature stabilization during hydraulic performance tests of short duration. If the purchaser desires temperature stabilization testing, this requirement should be stated in the inquiry and addressed by the vendor in the proposal.		Note: Pumps equipped with ring-oiled or splash lubrication systems may not reach temperature stabilization during hydraulic performance tests of short duration. If the purchaser desires temperature stabilization testing, this requirement should be stated in the inquiry and addressed by the vendor in the proposal.	
9.1.4.2.3 Where water cooling is required, water jackets shall have only external connections between upper and lower housing jackets and shall have neither gasketed nor threaded connection joints which may allow water to leak into the oil reservoir. If cooling coils (including fittings) are used, they shall be of nonferrous material and shall have no internal pressure joints. Tubing or pipe shall have a minimum thickness of 1.0 mm (0.040 in.) and shall be at least 12 mm (0.50 in.) outside diameter.		9.1.4.2.3 Where water cooling is required, water jackets shall have only external connections between upper and lower housing jackets and shall have neither gasketed nor threaded connection joints which may allow water to leak into the oil reservoir. If cooling coils (including fittings) are used, they shall be of nonferrous material and shall have no internal pressure joints. Tubing or pipe shall have a minimum thickness of 1.0 mm (0.040 in.) and shall be at least 12 mm (0.50 in.) outside diameter.	
9.1.4.2.4 Bearing housings, load-carrying bearing covers, and brackets between the pump casing or cover shall be steel.		9.1.4.2.4 Bearing housings, load-carrying bearing covers, and brackets between the pump casing or cover shall be steel.	
9.1.4.2.5 Bearing housings shall be equipped with replaceable labyrinth end seals and deflectors where the shaft passes through the housing; lip seals shall not be used. The seals and deflectors shall be made of nonsparking materials. The design of the seals and deflectors shall effectively retain oil in the housing and prevent entry of foreign material into the housing.		9.1.4.2.5 Bearing housings shall be equipped with replaceable labyrinth end seals and deflectors where the shaft passes through the housing; lip seals shall not be used. The seals and deflectors shall be made of nonsparking materials. The design of the seals and deflectors shall effectively retain oil in the housing and prevent entry of foreign	

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		material into the housing.	
9.1.4.2.6 Housings for ring oil lubricated bearings shall be provided with plugged ports positioned to allow visual inspection of the oil rings while the pump is running.		9.1.4.2.6 Housings for ring oil lubricated bearings shall be provided with plugged ports positioned to allow visual inspection of the oil rings while the pump is running.	
9.1.4.2.7 Bearings and bearing housings shall meet the requirements of 9.1.4.2.7.1 through 9.1.4.2.7.4 when oil mist lubrication is specified (see 9.1.4.3.3).		9.1.4.2.7 Bearings and bearing housings shall meet the requirements of 9.1.4.2.7.1 through 9.1.4.2.7.4 when oil mist lubrication is specified (see 9.1.4.3.3).	
9.1.4.2.7.1 An oil mist inlet connection, 1/4 NPS, shall be provided in the top half of the bearing housing. The pure or purge oil mist fitting connections shall be located so that oil mist will flow through rolling element bearings. On pure-mist systems, there shall be no internal passage to short circuit oil mist from inlet to vent.		9.1.4.2.7.1 An oil mist inlet connection, 1/4 NPS, shall be provided in the top half of the bearing housing. The pure or purge oil mist fitting connections shall be located so that oil mist will flow through rolling element bearings. On pure-mist systems, there shall be no internal passage to short circuit oil mist from inlet to vent.	
9.1.4.2.7.2 A 1/4 NPS vent connection shall be provided on the housing or end cover for each of the spaces between the rolling element bearings and the housing shaft closures. Alternatively, where oil mist connections are between each housing shaft closure and the bearings, one vent central to the housing shall be supplied.		9.1.4.2.7.2 A 1/4 NPS vent connection shall be provided on the housing or end cover for each of the spaces between the rolling element bearings and the housing shaft closures. Alternatively, where oil mist connections are between each housing shaft closure and the bearings, one vent central to the housing shall be supplied.	
9.1.4.2.7.3 Shielded or sealed bearings shall not be used.		9.1.4.2.7.3 Shielded or sealed bearings shall not be used.	
9.1.4.2.7.4 When pure oil mist lubrication is specified, oil rings or flingers (if any) and constant level oilers shall not be provided, and a mark indicating the oil level is not required. When purge mist lubrication is specified, these items shall be		9.1.4.2.7.4 When pure oil mist lubrication is specified, oil rings or flingers (if any) and constant level oilers shall not be provided, and a mark indicating the oil level is not required.	

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provided and the oiler shall be piped so that it is maintained at the internal pressure of the bearing housing.		When purge mist lubrication is specified, these items shall be provided and the oiler shall be piped so that it is maintained at the internal pressure of the bearing housing.	
Note: At pumping temperatures above 300°C (570°F), bearing housings with pure oil mist lubrication may require special features to reduce heating of the bearing races by heat transfer from the pumpage. Typical features are as follows:		Note: At pumping temperatures above 300°C (570°F), bearing housings with pure oil mist lubrication may require special features to reduce heating of the bearing races by heat transfer from the pumpage. Typical features are as follows:	
a. Heat sink type flingers.		a. Heat sink type flingers.	
b. Stainless steel shafts having low thermal conductivity.		b. Stainless steel shafts having low thermal conductivity.	
c. Thermal barriers.		c. Thermal barriers.	
d. Fan cooling.		d. Fan cooling.	
e. Purge mist lubrication (in place of pure mist) with oil (sump) cooling.		e. Purge mist lubrication (in place of pure mist) with oil (sump) cooling.	
The oil mist supply and drain fittings will be provided by the purchaser.		The oil mist supply and drain fittings will be provided by the purchaser.	
9.1.4.3 Antifriction Bearing Lubrication		9.1.4.3 Antifriction Bearing Lubrication	
9.1.4.3.1 Bearings and bearing housings shall be arranged for oil lubrication.		9.1.4.3.1 Unless otherwise specified, bearings and bearing housings shall be <b>arranged</b> designed for oil lubrication using a mineral (hydrocarbon) oil.	
9.1.4.3.2 Flingers or oil rings used to deliver oil to the bearings shall have an operating submergence of 3 to 6 mm (0.12 – 0.25 in.) above the lower edge of a flinger or above the lower edge of the bore of an oil ring. Oil flingers shall have mounting hubs to maintain concentricity and shall be positively secured to the shaft.		9.1.4.3.2 <del>Flingers or oil rings used to deliver oil to the bearings shall have an operating submergence of 3 to 6 mm (0.12 – 0.25 in.) above the lower edge of a flinger or above the lower edge of the bore of an oil ring. Oil flingers shall have mounting hubs to maintain concentricity</del>	

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		<del>and shall be positively secured to the shaft.</del>	
9.1.4.3.3 When specified, provisions shall be made for either pure oil or purge oil mist lubrication (see 7.1.2.2.7 for requirements).		9.1.4.3.3 <del>When</del> If specified, provisions shall be made for either pure oil or purge oil mist lubrication (see 7.1.2.2.7 for requirements).	
		<p>If specified, rolling-element bearings shall be grease-lubricated in accordance with a) through d) below.</p> <p>a) Grease life (re-lubrication interval) shall be estimated using the method recommended by the bearing manufacturer or an alternative method approved by the purchaser.</p> <p>b) Grease lubrication shall not be used if the estimated grease life is less than 2 000 h.</p> <p>c) If the estimated grease life is 2 000 h or greater but less than 25 000 h, provision shall be made for regreasing the bearings in service and for the effective discharge of old or excess grease, and the vendor shall advise the purchaser of the required re-greasing interval.</p> <p>d) If the estimated grease life is 25 000 h or more, grease nipples or any other system for the addition of grease in service shall not be fitted.</p>	<p><b>Design of anti friction bearings:</b>                  We suggest to implement optional grease lubrication for the antifriction bearings (already part of API 610 / ISO 13709).</p>
<b>9.1.5 Accessories</b>		<b>9.1.5 Accessories</b>	
9.1.5.1 DRIVERS		9.1.5.1 DRIVERS	
9.1.5.1.1 The purchaser will specify the type of driver, its characteristics, and the accessories, including the following:		9.1.5.1.1 The purchaser will specify the type of driver, its characteristics, and the accessories, including the following:	
a. Electrical characteristics.		a. Electrical characteristics.	

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b. Starting conditions (including the expected voltage drop on starting).		b. Starting conditions (including the expected voltage drop on starting).	
c. The type of enclosure.		c. The type of enclosure.	
d. The sound pressure level.		d. The sound pressure level.	
e. The area classification, based on API Recommended Practice 500A.		e. The area classification, based on API Recommended Practice 500A.	
f. The type of insulation.		f. The type of insulation.	
g. The required service factor.		g. The required service factor.	
h. The ambient temperature and elevation above sea level.		h. The ambient temperature and elevation above sea level.	
i. Transmission losses.		i. Transmission losses.	
j. Temperature detectors, vibration sensors, and heaters, if these are required.		j. Temperature detectors, vibration sensors, and heaters, if these are required.	
k. Vibration acceptance criteria.		k. Vibration acceptance criteria.	
l. Applicability of API Standard 541 or IEEE 841.		l. Applicability of API Standard 541 or IEEE 841.	
9.1.5.1.2 Unless otherwise specified, steam turbine drivers shall conform to ISO 10436 (API Standard 611). Steam turbine drivers shall be sized to deliver continuously 110 percent of the maximum power required for the purchaser's specified conditions while operating at corresponding speed with specified steam conditions.		9.1.5.1.2 Unless otherwise specified, steam turbine drivers shall conform to ISO 10436 (API Standard 611). Steam turbine drivers shall be sized to deliver continuously 110 percent of the maximum power required for the purchaser's specified conditions while operating at corresponding speed with specified steam conditions.	
9.1.5.1.3 Unless otherwise specified, gears shall conform to API Standard 677.		9.1.5.1.3 Unless otherwise specified, gears shall conform to API Standard 677.	
9.1.5.1.4 For drive train components that weigh more than 450 kg (1000 lbs), the equipment feet shall be provided with vertical jackscrews.		9.1.5.1.4 For drive train components that weigh more than 450 kg (1000 lbs), the equipment feet shall be provided with vertical jackscrews.	

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9.1.5.1.5 The driver feet shall be drilled with pilot holes that are accessible for use in final doweling.		9.1.5.1.5 The driver feet shall be drilled with pilot holes that are accessible for use in final doweling.	
9.1.5.2 Shaft Couplings and Guards		9.1.5.2 Shaft Couplings and Guards	
9.1.5.2.1 Unless otherwise specified, couplings and guards between drivers and driven equipment shall be supplied by the vendor.		9.1.5.2.1 Unless otherwise specified, couplings and guards between drivers and driven equipment shall be supplied by the vendor.	
9.1.5.2.2 Unless otherwise specified, couplings shall be flexible-element. Coupling hubs shall be steel. Flexible disk types shall have disks of corrosion resistant material. The make, model, materials, service factor, and mounting arrangement of couplings will be specified by the purchaser. A spacer coupling shall be used unless otherwise specified. The spacer shall have a nominal length of at least 125 mm (5 in.) and shall permit removal of the back pullout assembly without disturbing the driver or the suction and discharge piping.		9.1.5.2.2 Unless otherwise specified, couplings shall be flexible-element. Coupling hubs shall be steel. Flexible disk types shall have disks of corrosion resistant material. The make, model, materials, service factor, and mounting arrangement of couplings will be specified by the purchaser. A spacer coupling shall be used unless otherwise specified. The spacer shall have a nominal length of at least 125 mm (5 in.) and shall permit removal of the back pullout assembly without disturbing the driver or the suction and discharge piping.	
Note: For flexible-element couplings, consideration should be given to designs that will retain the spacer if a flexible element ruptures.		Note: For flexible-element couplings, consideration should be given to designs that will retain the spacer if a flexible element ruptures.	
9.1.5.2.3 Information on shafts, keyway dimensions (if any), and shaft end movements due to end play and thermal effects shall be furnished to the vendor supplying the coupling.		9.1.5.2.3 Information on shafts, keyway dimensions (if any), and shaft end movements due to end play and thermal effects shall be furnished to the vendor supplying the coupling.	
9.1.5.2.4 Flexible couplings shall be keyed to the shaft. Keys, keyways, and fits shall conform to ISO/R773 (ANSI/AGMA 9002, Commercial		9.1.5.2.4 Flexible couplings shall be keyed to the shaft. Keys, keyways, and fits shall conform to ISO/R773	

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<p>Class). Flexible couplings with cylindrical bores shall have the interference fit specified in ISO/R286, Tolerance N8, and shafting in accordance with ISO/R775 (ANSI/AGMA 9002). Where the shaft diameter is greater than 60 mm (2 1/2 in.), the hub shall be mounted with a taper fit. Taper for keyed couplings shall be 1:10 long series conical in accordance with ISO/R775, or alternately 1:16 (0.75 in./ft, diametral) for compliance with U.S. Standards. Other mounting methods shall be agreed upon by the purchaser and the vendor. Coupling hubs shall be furnished with tapped puller holes at least 10 mm (3/8 in.) in size to aid in removal.</p>		<p>(ANSI/AGMA 9002, Commercial Class). Flexible couplings with cylindrical bores shall have the interference fit specified in ISO/R286, Tolerance N8, and shafting in accordance with ISO/R775 (ANSI/AGMA 9002). Where the shaft diameter is greater than 60 mm (2 1/2 in.), the hub shall be mounted with a taper fit. Taper for keyed couplings shall be 1:10 long series conical in accordance with ISO/R775, or alternately 1:16 (0.75 in./ft, diametral) for compliance with U.S. Standards. Other mounting methods shall be agreed upon by the purchaser and the vendor. Coupling hubs shall be furnished with tapped puller holes at least 10 mm (3/8 in.) in size to aid in removal.</p>	
<p>Note: Appropriate assembly and maintenance procedures must be used to assure that taper fit couplings have an interference fit.</p>		<p>Note: Appropriate assembly and maintenance procedures must be used to assure that taper fit couplings have an interference fit.</p>	
<p>9.1.5.2.5 Couplings and coupling to shaft junctures shall be rated for at least the maximum driver power, including any service factor.</p>		<p>9.1.5.2.5 Couplings and coupling to shaft junctures shall be rated for at least the maximum driver power, including any service factor.</p>	
<p>9.1.5.2.6 Couplings shall be manufactured to meet the requirements of ANSI/AGMA 9000, Class 9.</p>		<p>9.1.5.2.6 Couplings shall be manufactured to meet the requirements of ANSI/AGMA 9000, Class 9.</p>	
<p>9.1.5.2.7 Couplings operating at speeds of 3800 rpm or less shall be component balanced. Components such as hubs, sleeves, flexible elements, spacers and adapters shall be balanced individually. All machining of components, except keyways of single keyed hubs, shall be completed before balancing. Balancing shall be in accordance with 6.9.4.1. Two-plane balancing is preferred; however, single-plane balancing may be used in</p>		<p>9.1.5.2.7 Couplings operating at speeds of 3800 rpm or less shall be component balanced. Components such as hubs, sleeves, flexible elements, spacers and adapters shall be balanced individually. All machining of components, except keyways of single keyed hubs, shall be completed before balancing. Balancing shall be in accordance with 6.9.4.1. Two-plane balancing is preferred; however,</p>	

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accordance with 6.9.4.2.		single-plane balancing may be used in accordance with 6.9.4.2.	
9.1.5.2.8 Limited end float couplings with maximum coupling end floats as specified in Table 9 shall be supplied with horizontal sleeve bearing motors to prevent the motor rotor from rubbing stationary motor parts.		9.1.5.2.8 Limited end float couplings with maximum coupling end floats as specified in Table 9 shall be supplied with horizontal sleeve bearing motors to prevent the motor rotor from rubbing stationary motor parts.	
Note: Couplings with axial elastic centering forces are usually satisfactory without these precautions.		Note: Couplings with axial elastic centering forces are usually satisfactory without these precautions.	
9.1.5.2.9 When the vendor is not required to mount the driver, the vendor shall deliver the fully machined half coupling to the driver manufacturer's plant or any other designated location, together with the necessary instructions for mounting the half coupling on the driver shaft.		9.1.5.2.9 When the vendor is not required to mount the driver, the vendor shall deliver the fully machined half coupling to the driver manufacturer's plant or any other designated location, together with the necessary instructions for mounting the half coupling on the driver shaft.	
9.1.5.2.10 Removable coupling guards shall be furnished and shall be in accordance with requirements of applicable national, industrial, or statutory bodies.		9.1.5.2.10 Removable coupling guards shall be furnished and shall be in accordance with requirements of applicable national, industrial, or statutory bodies.	
9.1.5.3 BASEPLATES		9.1.5.3 BASEPLATES	
9.1.5.3.1 Single-piece drain rim or drain pan baseplates shall be furnished for horizontal pumps. The rim or pan of the baseplate shall be sloped at least 1:120 toward the pump end, where a tapped drain opening at least 2 NPS shall be located to effect complete drainage.		9.1.5.3.1 Single-piece drain rim or drain pan baseplates shall be furnished for horizontal pumps. The rim or pan of the baseplate shall be sloped at least 1:120 toward the pump end, where a tapped drain opening at least 2 NPS shall be located to effect complete drainage.	
9.1.5.3.2 Unless otherwise specified, the baseplate shall extend under the pump and drive train components so that any leakage is contained within the baseplate. To minimize accidental bumping and damage to components, all pipe joints and pipe		9.1.5.3.2 Unless otherwise specified, the baseplate shall extend under the pump and drive train components so that any leakage is contained within the baseplate. To minimize accidental bumping and	

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<p>flange faces, including pump suction and discharge flanges, shall be within the drain pan or drain rim collection area. All other projections of the equipment supplied shall fall within the maximum perimeter of the baseplate. Oversized junction boxes may overhang the perimeter of the baseplate with the purchaser's approval.</p>		<p>damage to components, all pipe joints and pipe flange faces, including pump suction and discharge flanges, shall be within the drain pan or drain rim collection area. All other projections of the equipment supplied shall fall within the maximum perimeter of the baseplate. Oversized junction boxes may overhang the perimeter of the baseplate with the purchaser's approval.</p>	
<p>9.1.5.3.3 Mounting pads shall be provided for the pump and all drive train components. The pads shall be larger than the foot of the mounted equipment to allow leveling of the baseplate without removal of the equipment. The pads shall be fully machined flat and parallel. Corresponding surfaces shall be in the same plane within 150 µm/m (0.002 in./ft) of distance between the pads. This requirement shall be met by supporting and clamping the baseplate at the foundation bolt holes only.</p>		<p>9.1.5.3.3 Mounting pads shall be provided for the pump and all drive train components. The pads shall be larger than the foot of the mounted equipment to allow leveling of the baseplate without removal of the equipment. The pads shall be fully machined flat and parallel. Corresponding surfaces shall be in the same plane within 150 µm/m (0.002 in./ft) of distance between the pads. This requirement shall be met by supporting and clamping the baseplate at the foundation bolt holes only.</p>	
<p>9.1.5.3.4 All pads for drive train components shall be machined to allow for the installation of shims at least 3 mm (0.12 in.) thick under each component. When the vendor mounts the components, a set of stainless steel shims at least 3 mm (0.12 in.) thick shall be furnished. When the vendor does not mount the components, the pads shall not be drilled, and shims shall not be provided.</p>		<p>9.1.5.3.4 All pads for drive train components shall be machined to allow for the installation of shims at least 3 mm (0.12 in.) thick under each component. When the vendor mounts the components, a set of stainless steel shims at least 3 mm (0.12 in.) thick shall be furnished. When the vendor does not mount the components, the pads shall not be drilled, and shims shall not be provided.</p>	
<p>9.1.5.3.5 To minimize misalignment of the pump and driver shafts due to piping load effects, the pump and its baseplate shall be constructed with</p>		<p>9.1.5.3.5 To minimize misalignment of the pump and driver shafts due to piping load effects, the pump and its baseplate</p>	

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<p>sufficient structural stiffness to limit displacement of the pump shaft at the drive end of the shaft or at the register fit of the coupling hub to the values shown in Table 10 during a test in accordance with 7.1.5.3.6. Grout or bearing housing supports (wobble plates) shall not be used as a means of obtaining the required stiffness. (It is recognized that grout can significantly increase the stiffness of the baseplate assembly; by neglecting this effect, the adequacy of the baseplate can easily be verified at the vendor's shop.)</p>		<p>shall be constructed with sufficient structural stiffness to limit displacement of the pump shaft at the drive end of the shaft or at the register fit of the coupling hub to the values shown in Table 10 during a test in accordance with 7.1.5.3.6. Grout or bearing housing supports (wobble plates) shall not be used as a means of obtaining the required stiffness. (It is recognized that grout can significantly increase the stiffness of the baseplate assembly; by neglecting this effect, the adequacy of the baseplate can easily be verified at the vendor's shop.)</p>	
<p>9.1.5.3.6 When specified, the vendor shall test to demonstrate that the pump and its baseplate assembly, when anchored at foundation bolt hole locations with any bearing housing support disconnected, are in compliance with 9.1.5.3.5. The pump casing shall be subjected to moments MYC and MZC applied to either nozzle, but not both, such that the corresponding shaft displacements can be measured and recorded. MYC and MZC shall not be applied simultaneously. The shaft displacement measurements shall be absolute (not relative to the baseplate). For record purposes, the vendor's test data shall include a schematic drawing of test setup, the calculated moment loads (MYC and MZC), and the applied moment loads and their corresponding displacements at the drive end of the pump shaft.</p>		<p>9.1.5.3.6 When specified, the vendor shall test to demonstrate that the pump and its baseplate assembly, when anchored at foundation bolt hole locations with any bearing housing support disconnected, are in compliance with 9.1.5.3.5. The pump casing shall be subjected to moments MYC and MZC applied to either nozzle, but not both, such that the corresponding shaft displacements can be measured and recorded. MYC and MZC shall not be applied simultaneously. The shaft displacement measurements shall be absolute (not relative to the baseplate). For record purposes, the vendor's test data shall include a schematic drawing of test setup, the calculated moment loads (MYC and MZC), and the applied moment loads and their corresponding displacements at the drive end of the pump shaft.</p>	
<p>9.1.5.3.7 The underside of fabricated baseplates</p>		<p>9.1.5.3.7 The underside of fabricated</p>	

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<p>beneath pump and driver supports shall be welded to reinforcing cross members, and the members shall be shaped to lock positively into the grout. All welding shall be continuous. Stitch welding, top or bottom, is unacceptable.</p>		<p>baseplates beneath pump and driver supports shall be welded to reinforcing cross members, and the members shall be shaped to lock positively into the grout. All welding shall be continuous. Stitch welding, top or bottom, is unacceptable.</p>	
<p>9.1.5.3.8 In addition to the requirements of 7.1.5.3.7, anchor studs, such as "J" hooks, shall be welded to the underside of baseplate decks on maximum 300 mm (12 in.) centers to provide additional locking into the grout.</p>		<p>9.1.5.3.8 In addition to the requirements of 7.1.5.3.7, anchor studs, such as "J" hooks, shall be welded to the underside of baseplate decks on maximum 300 mm (12 in.) centers to provide additional locking into the grout.</p>	
<p>9.1.5.3.9 All baseplates shall be provided with at least one grout hole having a clear area of at least 125 cm<sup>2</sup> (19 in.<sup>2</sup>) and no dimension less than 75 mm (3 in.) in each bulkhead section. These holes shall be located to permit filling the entire cavity under the baseplate without creating air pockets. Where practical, the holes shall be accessible for grouting with the pump and driver installed on the baseplate. Grout holes in the drip-pan area shall have 13 mm (0.5 in.) raised lip edges. If the holes are located in an area where liquids could impinge on the exposed grout, metallic covers with a minimum thickness of 1.5 mm (16 gauge) shall be provided. Vent holes at least 13 mm (0.5 in.) in diameter shall be provided at the highest point in each bulkhead section of the baseplate. (Appendix L provides guidelines for grouting.)</p>		<p>9.1.5.3.9 All baseplates shall be provided with at least one grout hole having a clear area of at least 125 cm<sup>2</sup> (19 in.<sup>2</sup>) and no dimension less than 75 mm (3 in.) in each bulkhead section. These holes shall be located to permit filling the entire cavity under the baseplate without creating air pockets. Where practical, the holes shall be accessible for grouting with the pump and driver installed on the baseplate. Grout holes in the drip-pan area shall have 13 mm (0.5 in.) raised lip edges. If the holes are located in an area where liquids could impinge on the exposed grout, metallic covers with a minimum thickness of 1.5 mm (16 gauge) shall be provided. Vent holes at least 13 mm (0.5 in.) in diameter shall be provided at the highest point in each bulkhead section of the baseplate. (Appendix L provides guidelines for grouting.)</p>	
<p>9.1.5.3.10 The outside corners of the baseplate in contact with the grout shall have at least 50 mm (2 in.) radii in the plan view (see Figure M-1,</p>		<p>9.1.5.3.10 The outside corners of the baseplate in contact with the grout shall have at least 50 mm (2 in.) radii in the</p>	

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Appendix M).		plan view (see Figure M-1, Appendix M).	
9.1.5.3.11 The bottom of the baseplate between structural members shall be open. When the baseplate is installed on a concrete foundation, accessibility shall be provided for grouting under all load carrying members. The bottom of the baseplate shall be in one plane to permit use of a single level foundation.		9.1.5.3.11 The bottom of the baseplate between structural members shall be open. When the baseplate is installed on a concrete foundation, accessibility shall be provided for grouting under all load carrying members. The bottom of the baseplate shall be in one plane to permit use of a single level foundation.	
9.1.5.3.12 When driver and pump size permit, baseplates shall have standardized dimensions as given in Appendix M and shall be designed for grouting. These baseplates shall be referred to as "API Standard 610 Standard Baseplates, Numbers 0.5–12."		9.1.5.3.12 When driver and pump size permit, baseplates shall have standardized dimensions as given in Appendix M and shall be designed for grouting. These baseplates shall be referred to as "API Standard 610 Standard Baseplates, Numbers 0.5–12."	
9.1.5.3.13 When specified, the baseplate and pedestal support assembly shall be sufficiently rigid to be mounted without grouting.		9.1.5.3.13 When specified, the baseplate and pedestal support assembly shall be sufficiently rigid to be mounted without grouting.	
9.1.5.3.14 Transverse alignment positioning jackscrews shall be provided for drive train components weighing more than 200 kg (450 lb) to facilitate transverse horizontal adjustments. Axial alignment positioning jackscrews shall be provided for drive train components weighing more than 400 kg (900 lb) to facilitate longitudinal adjustments. The lugs holding these positioning screws shall be attached to the baseplate so that the lugs do not interfere with the installation or removal of the component. These screws shall be at least the same size as vertical jackscrews furnished with each component. To prevent distortion, machining of mounting pads shall be deferred until welding on the baseplate in close proximity to the mounting		9.1.5.3.14 Transverse alignment positioning jackscrews shall be provided for drive train components weighing more than 200 kg (450 lb) to facilitate transverse horizontal adjustments. Axial alignment positioning jackscrews shall be provided for drive train components weighing more than 400 kg (900 lb) to facilitate longitudinal adjustments. The lugs holding these positioning screws shall be attached to the baseplate so that the lugs do not interfere with the installation or removal of the component. These screws shall be at least the same size as vertical jackscrews furnished with	

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pads has been completed.		each component. To prevent distortion, machining of mounting pads shall be deferred until welding on the baseplate in close proximity to the mounting pads has been completed.	
9.1.5.3.15 Vertical leveling screws spaced for stability shall be provided on the outside perimeter of the baseplate. They shall be located adjacent to anchor bolts to minimize distortion during the process of installation. These screws shall be numerous enough to carry the weight of the baseplate, pump, and drive train components without excessive deflection, but in no case shall fewer than 6 screws be provided.		9.1.5.3.15 Vertical leveling screws spaced for stability shall be provided on the outside perimeter of the baseplate. They shall be located adjacent to anchor bolts to minimize distortion during the process of installation. These screws shall be numerous enough to carry the weight of the baseplate, pump, and drive train components without excessive deflection, but in no case shall fewer than 6 screws be provided.	
9.1.5.3.16 The height of the pump shaft centerline above the baseplate shall be minimized. Adequate clearance shall be provided between the casing drain connection and the baseplate so that drain piping the same size as the connection can be installed without the use of a street (male-female) elbow.		9.1.5.3.16 The height of the pump shaft centerline above the baseplate shall be minimized. Adequate clearance shall be provided between the casing drain connection and the baseplate so that drain piping the same size as the connection can be installed without the use of a street (male-female) elbow.	
9.1.5.3.17 Unless otherwise specified, the vendor shall commercially sand blast, in accordance with SSPC SP 6, all grout contact surfaces of the baseplate, and coat those surfaces with inorganic zinc silicate in preparation for epoxy grouting.		9.1.5.3.17 Unless otherwise specified, the vendor shall commercially sand blast, in accordance with SSPC SP 6, all grout contact surfaces of the baseplate, and coat those surfaces with inorganic zinc silicate in preparation for epoxy grouting.	
9.1.5.3.18 Baseplates which are specified to be installed with cementitious grout shall have grout contact surfaces left free of paint and primer in order to promote maximum grout adhesion.		9.1.5.3.18 Baseplates which are specified to be installed with cementitious grout shall have grout contact surfaces left free of paint and primer in order to promote maximum grout adhesion.	

API 685 First Edition	Source	Proposed Revision	Reason for Change
<p>9.1.5.3.19 The baseplate shall be provided with lifting lugs for at least a 4-point lift. Lifting the baseplate, complete with all equipment mounted, shall not permanently distort or otherwise damage the baseplate or the machinery mounted on it.</p>		<p>9.1.5.3.19 The baseplate shall be provided with lifting lugs for at least a 4-point lift. Lifting the baseplate, complete with all equipment mounted, shall not permanently distort or otherwise damage the baseplate or the machinery mounted on it.</p>	
<p>9.1.5.3.20 Anchor bolts will be furnished by the purchaser. The vendor shall provide for sufficient anchor bolting to withstand nozzle reaction forces during pump start-up and operation.</p>		<p>9.1.5.3.20 Anchor bolts will be furnished by the purchaser. The vendor shall provide for sufficient anchor bolting to withstand nozzle reaction forces during pump start-up and operation.</p>	
<p><b>9.1.6 Testing</b></p>		<p><b>9.1.6 Testing</b></p>	
<p>9.1.6.1 Static torque testing data shall be available for each coupling rating, and when specified shall be submitted for purchaser review. When specified, magnetic couplings shall be given a static torque test to verify the rated torque (reference 9.1.3.8) and certification shall be provided. The test shall be performed at ambient temperature and corrected for maximum allowable temperature.</p>		<p>9.1.6.1 Static torque testing data shall be available for each coupling rating, and when specified shall be submitted for purchaser review. When specified, magnetic couplings shall be given a static torque test to verify the rated torque (reference 9.1.3.8) and certification shall be provided. The test shall be performed at ambient temperature and corrected for maximum allowable temperature.</p>	
<p>9.1.6.2 Prior to actual performance testing, the pump manufacturer shall advise the shop procedure for quantifying eddy-current losses and for correcting water test results to performance on specified job fluid(s).</p>		<p>9.1.6.2 Prior to actual performance testing, the pump manufacturer shall advise the shop procedure for quantifying eddy-current losses and for correcting water test results to performance on specified job fluid(s).</p>	
<p><b>9.1.7 Preparation for Shipment</b></p>		<p><b>9.1.7 Preparation for Shipment</b></p>	
<p>9.1.7.1 Exposed shafts and shaft couplings (magnetic drive pumps) shall be wrapped with waterproof, moldable waxed cloth or volatile-corrosion inhibitor paper. The seams shall be sealed with oil-proof adhesive tape.</p>		<p>9.1.7.1 Exposed shafts and shaft couplings (magnetic drive pumps) shall be wrapped with waterproof, moldable waxed cloth or volatile-corrosion inhibitor paper. The seams shall be</p>	

API 685 First Edition	Source	Proposed Revision	Reason for Change
		sealed with oil-proof adhesive tape.	
<p>9.1.7.2 Bearing assemblies (magnetic drive pumps) shall be fully protected from the entry of moisture and dirt. If vapor phase-inhibitor crystals in bags are installed in large cavities to absorb moisture, the bags must be attached in an accessible area for ease of removal. Where applicable, bags shall be installed in wire cages attached to flanged covers. Bag locations shall be indicated by corrosion-resistant tags attached with stainless steel wire.</p>		<p>9.1.7.2 Bearing assemblies (magnetic drive pumps) shall be fully protected from the entry of moisture and dirt. If vapor phase-inhibitor crystals in bags are installed in large cavities to absorb moisture, the bags must be attached in an accessible area for ease of removal. Where applicable, bags shall be installed in wire cages attached to flanged covers. Bag locations shall be indicated by corrosion-resistant tags attached with stainless steel wire.</p>	
<p><b>9.2 CANNED MOTOR PUMPS</b></p>			
<p><b>9.2.1 General</b></p>			
<p>Canned Motor Pumps are designated as Type CMP. A description of Type CMP is given in Appendix C.</p>			
<p><b>9.2.2 Motor Requirements</b></p>			
<p>9.2.2.1 The stator housing of a canned motor pump, including the electrical feed through barrier, shall be designed for the pressure casing maximum allowable working pressure, associated hydrostatic test pressure and operating temperature range.</p>			
<p>9.2.2.2 The stator cavity on motors for pumps built for services which have operating temperature of 160°C (320°F) or less shall not be filled with oil. When approved by the purchaser, solid heat transfer material may be used to conduct heat away from the stator windings. Pumps built for services which have operating temperatures in excess of 160°C (320°F), shall have ceramic insulated stators or shall incorporate a cooling system.</p>		<p>The stator cavity on motors for pumps built for services which have operating temperature of 160°C (320°F) or more shall not be filled with oil. When approved by the purchaser, solid heat transfer material may be used to conduct heat away from the stator windings. Pumps built for services which have operating temperatures in excess of 160°C (320°F), shall have ceramic</p>	<p>Oil filled stators are acceptable with a properly sized stator housing and junction box.</p> <p>Elimination of oil is too limiting on the manufacturer. This standard should not specify temperatures for various insulations.</p>

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		insulated stators or shall incorporate a cooling system.  When approved by purchaser the stator cavity can be filled with a liquid or solid heat transfer material. Motor insulation, including heat transfer material, shall be suitable for the temperature of the process fluid.	
9.2.2.3 Electrical feed through barrier to canned motor junction box shall be located above the pump centerline and shall be self-draining into the stator cavity.		Electrical feed through barrier to canned motor junction box shall be <del>located above the pump centerline and shall be</del> self-draining into the stator cavity.	Too limiting...Some manufacturers have electrical junction boxes located on the side.
9.2.2.4 The connection box shall be sized at least one size larger than the standard IEC (NEMA) size for the motor used.			
9.2.2.5 Motors shall be designed for across-the-line starting.	API 685 9.2.2.5	Motors shall be designed for across-the-line starting <u>except in those applications where a variable frequency drive will be used to obtain a soft start.</u>	Large size canned motors are increasingly being used in conjunction with variable frequency drives to reduce size and cost.
9.2.2.6 Motors rated below 150 kW (200 hp) shall be capable of 3 starts per hour when the initial start is from ambient temperature. Motors rated 150 kW and above shall be capable of 3 starts per hour but limited to 8 starts per day.			
9.2.2.7 The stator winding insulation shall be rated to allow the motor to satisfactorily operate for at least 175,000 hours at the maximum rated temperature and flow conditions.			Providing testing verification of this requirement is problematic.
9.2.2.8 Class F is the minimum acceptable class of insulation. Class C insulation shall not be used unless specifically approved by the purchaser.		<u>Class H 200°C(392°F) is the minimum acceptable class of insulation.</u> Class C insulation shall not be used unless specifically approved by the purchaser.	Class F insulation 155°C(311°F) is not adequate for many canned motor pump applications. Given that the motor is totally enclosed liquid cooled applications. The process fluid or

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			conditioned process fluid is used to cool the motor.
9.2.2.9 When specified, motors shall be designed for the special operating conditions, such as frequent starting and multi-speed operation, of the driven equipment. The vendor shall state the effect of these conditions on the expected operating life.			
9.2.2.10 When specified, UL, FM or equivalent certification shall be provided.		<u>The motor shall be rated and documented for the hazardous (classified) locations specified by the purchaser. Third party certification (UL, FM or equal) will be provided as necessary</u>	Currently too vague
9.2.2.11 When specified, a decontamination flush or purge connection shall be included on the stator assembly.		When specified, a decontamination flush or purge connections shall be included on the stator assembly.	
<b>9.2.3 Stator Liner</b>			
9.2.3.1 The stator assembly consisting of the stator, stator liner, liner backing supports, stator housing, and electrical feed-through is by definition a pressure-containing assembly and shall meet the requirements of 4.3 except as follows.			
a. The minimum stator liner corrosion allowance shall be 0.15 mm (0.005 in.).		<u>The stator liner shall be of a material that is non corrosive.</u>	There should be no corrosion allowance for the stator liner
b. The minimum stator liner thickness shall be 0.46 mm (0.018 in.).		<u>The minimum stator liner thickness shall be 0.38 mm (0.015 in.)</u>	0.018 in is too limiting.
c. The stator liner shall be hydrostatically tested in the stator assembly at 1.5 times the maximum allowable working pressure.			
9.2.3.2 The stator liner material shall conform to 6.11.			Delete..redundant statement
9.2.3.3 Stator liner materials not contained in Appendix H shall be subject to the approval of the			

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purchaser.			
<b>9.2.4 Rotor Liners</b>			
9.2.4.1 The minimum rotor liner corrosion allowance shall be 0.15 mm (0.005 in.).		The rotor liner material shall be non corrosive	There should be no corrosion allowance for the rotor liner
9.2.4.2 The rotor liner material shall conform to 6.11.			Delete..redundant statement
9.2.4.3 Rotor liner materials not contained in Appendix H shall be subject to the approval of the purchaser.			
<b>9.2.5 Additional Nameplate Requirements</b>			
9.2.5.1 In addition to the nameplate information required in 6.15.2, canned motor pump nameplates shall also include the following additional information:			
a. Rated motor voltage.			
b. Full load motor amperes.			
c. Motor insulation class			
d. Motor rated horsepower.			
e. Locked rotor amperes.			
f. Maximum allowed pump and motor working pressure at rated temperature.			
g. Date of manufacture.			
h. Pump impeller diameter.			
i. Pumped liquid identification.			
j. Motor thermal protection actuation temperature.			
9.2.5.2 For service in Class I, Division 1 Hazardous Areas, the following additional nameplate information is required:			

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a. Pumped liquid temperature limits (either by NFPA 70 or actual temperature).			
b. Label, note or logo indicating approval for use in Class I, Division I area.			
9.2.5.3 For variable speed drives, the following additional nameplate information is required: Motor speed range.			
<b>9.2.6 Submersible Canned Motor Pumps</b>			
When pumps are designed and supplied with a vessel nozzle cover plate, the cover plate shall be designed to the same maximum working pressure and temperature as the vessel on which it is mounted. If the vessel on which it is mounted is a pressure vessel, designed to ASME Section VIII, Division 1, then the cover plate shall be designed to the same criteria. The conduit from the motor to the cover plate is a part of the pressure casing and shall be designed in accordance with all requirements imposed on the pump pressure casing such as corrosion allowance, design pressure, and design temperature.			
<b>9.2.7 Testing</b>			
Motor tests shall consist of resistance measurements of the windings and dielectric tests to confirm the integrity of the winding insulation. The dielectric tests shall include the polarization index ratio measurement based on 1- and 10-minute readings. Tests shall be performed in accordance with IEEE 252 or other standards as agreed to by the purchaser. When specified, certification shall be provided by the vendor.		Motor tests shall consist of resistance measurements of the windings and dielectric tests to confirm the integrity of the winding insulation. <del>The dielectric tests shall include the polarization index ratio measurement based on 1- and 10-minute readings.</del> Tests shall be performed in accordance with IEEE 252 or other standards as agreed to by the purchaser. When specified, certification shall be provided by the vendor.	Remove. This test is meaningless in insulation resistance to ground exceeds 100 megaohms.

